Bot. Diatoms

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THE NATURAL HISTORY

OF THE

BRITISH DIATOMACEÆ

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BRITISH DIATOMACEÆ.

Section I. FRUSTULES NAKED.

Family I. NAVICULEÆ.

Frustules free, solitary, more or less elongated, straight or curved; extremities symmetrical. *Valve* more or less convex, straight or sigmoid, and divided into two equal halves by a longitudinal median line having a central and terminal nodules; surfaces of the valve on both sides of the median line covered partially or completely with hemispherical nodules arranged in transverse, oblique, or longitudinal lines, so as to form *striæ*, which are either *granular* or *costate*, according to the *aggregation* or *segregation* of the nodules.

The original researches of Mr. Wenham*, recently confirmed by the more complete observations of the Rev. J. B. Reade†, have demonstrated that the markings on the valves of the *Naviculeæ* are produced by hemispherical nodules projecting from the surfaces of the valve and arranged in lines inclined at varying angles to its longitudinal axis and to each other; the siliceous hemispheres on the

* Quart. Micr. Journ. vol. iii. p. 244, and Trans. Micr. Soc. n. s. vol. viii. p. 145.

† Monthly Micr. Journ. July 1869.

outer surface correspond with those of the inner, this correspondence being due, as Mr. Reade expresses it, "to perfect spheres of silica set equatorially in the siliceous tissue of the valve." Mr. Reade, however, objects to the term *striæ* as fitting to describe the linear arrangement of these hemispherical nodules; but as, under the highest magnifying-power usually employed by naturalists in describing and delineating the Diatomaceæ, these nodules produce a distinctly striated appearance, the term must necessarily be retained, and the adjective *granular* prefixed to it when the nodules are *segregated* and separately visible, and *costate* when they are so closely *aggregated* or packed as to be no longer *individually* recognizable, and to present the appearance *collectively* of ridges or costæ on the surface of the valve.

The *Naviculeæ* constitute by far the most numerous family of the *Diatomaceæ*, of which they are typical, both in the structure of the frustule and the peculiar power of motion they display. They abound in all latitudes and at every degree of elevation, from alpine springs and tarns down to the bed of the ocean, in fresh water and in water of every degree of saline impregnation; but, as stated in the Introduction, the marine and brackish-water species are never found in localities above the reach of tidal influences, while the freshwater species never occur living in marine habitats, and in exceptional instances only in brackish water.

NAVICULA, Bory de St. Vincent, 1822.

Frustules straight; on M.V. oblong, linear, or constricted in the middle, with rounded or truncate extremities. Valves*

* In the late Prof. Smith's 'Synopsis,' F.V. is used to indicate the '*primary side*' of Kützing and the '*secondary side*' of Rabenhorst, S.V.

symmetrical, straight, depressed (flattened) or highly convex, broad or narrow; outline various; median line straight; striæ granular or costate, extending from the margin in an oblique or transverse direction towards the median line, and either inclined at various angles or parallel to each other.

Two distinct and well-marked types of form or development are met with amongst the *Naviculæ*. In the first the valve is depressed or flattened, broad, and short (in proportion to its width), the convexity being slight and confined to near the margin. In the second the valve is elevated or convex, elongated, and narrow (in proportion to its length), the convexity being great and extending from the margin to the median line, where it is most prominent. In reconstructing this genus and rearranging its numerous species, I have adopted these two types as the basis of classification, because when the various species are grouped according as they present a preponderance of the one or the other type in their structure, the most natural arrangement is obtained, and, as a very general rule, those species are brought into proximity which present the strongest natural affinity or relationship, a few only being so aberrant in their characters as to be almost irreconcilable to any methodical classification whatever.

The linear arrangement of the hemispherical nodules into striæ on the surface of the valve in this genus is universal; on a portion only of the valve of *N. prætexta*, and a very few others, is this arrangement broken up, and the granules disposed irregularly. The nodules themselves

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being used to denote the *secondary side* of Kützing and the *primary* of Rabenhorst. The author has retained S.V. as denoting the *surface view of the valve*; but instead of F.V. he has introduced M.V. to express a view of the frustule exhibiting the *median connecting zone and the margins of the valves.*

vary much in size in different species, from being so minute (in *N. rhomboides* and others) as to be only visible with the highest magnifying-powers, to being large and distinctly visible with a low power (as in *N. prætexta, N. granulata,* &c.). The degree of segregation and of aggregation of the granules forming the striæ is also, in different species, subject to great variation. In *N. granulata* and others they are widely separated by a distinct interval between them; in *N. nobilis* and its allies, on the contrary, they are so closely packed as to present the appearance of smooth ridges or costæ on the surface of the valve. Between these opposite types every possible intermediate degree of variation prevails in different species, so that no definite limit can be drawn to separate the species with *visibly granular* striæ from those whose striæ are *apparently costate.* Consequently the genus *Pinnularia* of Ehrenberg, as reconstructed by the late Professor Smith*, must necessarily be abolished, not having been founded on any structural peculiarity which is more than purely specific. Undoubtedly the construction of this genus, and its adoption by several observers, has had the pernicious effect of separating species closely allied, and placing them in different genera, thus creating much confusion in the nomenclature of the subject. In numerous instances both Ehrenberg and Smith disregarded the distinction they had drawn between *Navicula* and *Pinnularia* in the classification of certain species. In the present work the latter genus has been reduced to a synonym of the former. In this respect the example of Prof. Kützing, M. De Brébisson, and Mr. Ralfs has been followed.

* Synop. of the British Diatomaceæ, vol. i. p. 54.

Section I. Valve broad, flattened.

Subsection I. *Valve elliptical or oval; striæ interrupted.*

A. *Extremities rounded; striæ reaching to the median line, but crossed or interrupted on each side of it by a longitudinal line, or two lines, extending between the apices of the valve.*

Navicula hyalina, Donkin.

Navicula hyalina, Donk. Quart. Micr. Journ. vol. i. n. s. p. 10, pl. i. fig. 6; Rabenh. Europ. Diat. p. 181.

Plate I. fig. 1.

V. linear-elliptical; striæ very fine, indistinct or obsolete; median line broad, tapering towards the central and terminal nodules, and bordered on either side by a doubly incurved longitudinal line; terminal nodules elongated, narrow.

The hyaline valve with striæ so delicate that they can be resolved only with extreme difficulty, even in dry specimens, together with the peculiar elongated, terminal nodules, appearing as if inserted into a cleft of the median line, are characters sufficiently distinguishing this species.

Hab. Marine. Coast of Northumberland, on the sands between tide-marks, at Cresswell and Boulmar.

Navicula littoralis, Donkin, n. sp.

Plate I. fig. 2.

V. oval; striæ slightly inclined, close, very fine, distinct, and crossed near to their inner ends by a straight longitudinal line, nearly parallel with the median line; dry valve yellowish brown.

This species is closely allied to *N. æstiva*, but readily

distinguished from it by its much smaller size, oval shape, much closer and finer striæ, by the *straight* longitudinal line crossing them, and by the colour of the dry valve.

Hab. Marine. Abundant in several localities on the sandy beach of Northumberland.

Navicula æstiva, Donkin.

Navicula æstiva, Donk. Trans. Micr. Soc. n. s. vol. vi. p. 32, pl. iii. fig. 18; Ralfs, in Prit. Inf. p. 899; Rabenh. Europ. Diat. p. 184.

Plate I. fig. 3.

Frustule large. V. elongate-elliptical; striæ fine, distinct, obscurely granular, subparallel, and crossed near the median line by a slightly incurved longitudinal line.

This species is distinguished from *N. Smithii*, Bréb., with which it is generally associated, by its more graceful form and much finer and much less granular striæ; dry valve blue.

Hab. Marine. On the sandy ripples of the sea-shore (plentiful) at Cresswell, Northumberland; South Shields (*A. S. D.*). Hull (*Mr. Norman*); New Brighton (*Mr. Comber*).

Navicula Smithii, De Brébisson.

Navicula Smithii, Bréb. in Smith's Synop. vol. ii. p. 92; Ralfs, in Prit. Inf. p. 898; Rabenh. Europ. Diat. p. 178.
Navicula elliptica, Smith, Synop. vol. i. p. 48, pl. xvii. fig. 152.
Navicula didyma, var., Smith, Synop. vol. i. p. 53, pl. xvii. fig. 154*a**.

Plate I. fig. 4.

Frustule large. V. oblong, linear-elliptical, with broadly

rounded extremities, sometimes slightly constricted in the middle with broad subcuneate extremities; striæ connivent, coarse, granular, about 18 in ·001″, interrupted near to the median line by a gently incurved longitudinal line.

Hab. Marine. Abundant in the sandy ripples on the sea-shore; Cresswell, Boulmar, and Tynemouth, Northumberland; South Shields (*A. S. D.*). Glenshira sand (*Prof. Gregory*).

Navicula fusca, Gregory.

Navicula Smithii, var. *fusca*, Greg. Diat. of the Clyde, p. 14, pl. i. fig. 15.
Navicula fusca, Ralfs, in Prit. Inf. p. 898; Rabenh. Europ. Diat. p. 179.
Navicula hyperborea, Grun. in Wien. Verh. 1860, p. 29, t. i. fig. 16.
Pinnularia quadrifasciata, Ehren. Mikrogeo. t. xix. fig. 25.

Plate I. fig. 5.

Frustule large. V. oblong-elliptical, or elongated oval; striæ connivent, very coarse and granular, about 12 in ·001″, bisected by a longitudinal incurved line; inner section narrow and fainter.

This species is readily distinguished from *N. Smithii*, to which it is closely allied, by its much more elegant figure, coarser striæ, larger size, and distinct brown colour of the valve in balsam.

Hab. Marine. Lamlash Bay Isle of Arran, Loch Fyne (*Prof. Gregory*); stomach of Ascidians near Hull (*Mr. Norman*).

Navicula elliptica, Kützing.

Navicula elliptica, Kütz. Bac. p. 98, t. xxx. fig. 55; Rabenh. Europ. Diat. p. 179; Sm. Synop. vol. ii. p. 92; Ralfs, in Prit. Inf. p. 899.
Navicula ovalis, Smith, Synop. vol. i. p. 48, pl. xvii. fig. 153.

Pinnularia cocconeoides, Rabenh. Süssw. Diat. p. 43, t. vi. fig. 18.
Cocconeis striata, Ehren. Mikrogeo. t. XV. B. fig. 16?
Cocconeis finnica, Ehren. Mikrogeo. t. XVII. ii. fig. 19?

Plate I. figs. 6*a* & 6*b*.

V. oval, or elliptical, or oblong-elliptical; striæ 27 in ·001″, distinct, connivent, granular, and crossed by a longitudinal incurved line, with a bulging-out opposite the central nodule. Variable in size and outline.

Hab. Fresh and brackish water, common. This is one of the few species thriving in either fresh or moderately brackish water; in the latter localities I have found some of the finest specimens.

Navicula nitescens, Gregory.

Navicula Smithii, var. *nitescens*, Greg. Diat. of the Clyde, p. 15, pl. i. fig. 16.
Navicula nitescens, Ralfs, in Prit. Inf. p. 898; Rabenh. Europ. Diat. p. 179.
Pinnularia Arraniensis, O'Meara, Quart. Micr. Journ. vol. vii. n. s. p. 116, pl. v. fig. 6.

Plate I. fig. 7.

V. elliptical, attenuated towards the extremities; striæ coarse, obscurely granular, about 16 in ·001″, converging towards the centre, and divided into two nearly equal sections by a longitudinal incurved line parallel with the margin.

Hab. Marine. Lamlash Bay Isle of Arran, and Loch Fyne (*Prof. Gregory*); stomach of Ascidians near Hull (*Mr. Norman*).

Navicula lineata, Donkin.

Navicula lineata, Donk. Trans. Micr. Soc. n. s. vol. vi. p. 32, pl. iii. fig. 17.

Plate I. fig. 8.

V. linear-elliptical, with a gentle constriction in the middle;

striæ divided by two longitudinal nearly parallel lines into three nearly equal sections; the two outer costate and slightly inclined, the innermost faint and granular; median line broad.

Mr. Ralfs (Prit. Infus. p. 899) has doubtfully referred this species to *Pinnularia quadrifasciata*, Ehren. (Mikrogeo. t. xix. fig. 27), so also has Rabenhorst without qualification (Europ. Diat. p. 214). The two species, however, are very dissimilar in their specific characters; *Pin.* (*Navicula*) *quadrifasciata* belongs to group B of the present subsection, and is closely allied to *N. spectabilis*, Greg., differing chiefly in being narrower, and in the narrower sublunate form of the longitudinal unstriated area on each half of the valve. Ehrenberg gives two figures of *Pin. quadrifasciata*; but one of them (fig. 25) is undoubtedly *N. fusca*, Greg. Both forms were discovered by him in the clay marl of Ægina, associated with *N. prætexta*. All three occur together in the Red Sea, from which I possess specimens. *N. quadrifasciata* has not been found in Britain, nor, to my knowledge, in the north of Europe.

Hab. Marine. In the ripples of the sandy beach between tide-marks (abundant), on the coast of Northumberland; New Brighton sands (*Mr. Comber*).

Navicula suborbicularis, Gregory.

Navicula Smithii, var. *suborbicularis*, Greg. Diat. of the Clyde, p. 15, pl. i. fig. 17.
Navicula suborbicularis, Ralfs, in Prit. Inf. p. 898.
Navicula forcipata, Grev., Rabenh. Europ. Diat. p. 178.
Pinnularia forficula, O'Meara, Quart. Micr. Journ. n. s. vol. vii. p. 117, pl. v. fig. 9.

Plate I. fig. 9.

Frustule small. V. short, broadly oval or suborbicular; median line broad, bordered by a doubly incurved

line; striæ coarse, much inclined, and divided by a doubly incurved longitudinal line into two sections, the inner narrow and faint, the outer broad, conspicuous, and costate, or obscurely granular.

Hab. Marine. Lamlash Bay Isle of Arran (*Prof. Gregory*).

Navicula pygmæa, Kützing.

Navicula pygmæa, Kütz. Spec. Alg. p. 77; Rabenh. Süssw. Diat. p. 39, and Europ. Diat. p. 184; Sm. Synop. vol. ii. p. 91; Ralfs, in Prit. Inf. p. 899.
Navicula minutula, Smith, Synop. vol. i. p. 48, pl. xxxi. fig. 274.

Plate I. fig. 10.

Frustule minute. V. elliptical or oblong-elliptical, hyaline; median line faint; striæ indistinct, very fine (80 in ·001″, Smith), and crossed by a faint, doubly incurved longitudinal line.

Hab. Brackish water, frequent.

B. *Extremities rounded or produced; striæ on each half of the valve separated into two bands (a marginal and a median) by an unstriated longitudinal area, extending between the extremities of the valve; median band narrow and interrupted by the central nodule.*

1. *Extremities rounded.*

Navicula prætexta, Ehrenberg.

Navicula prætexta, Ehr. Berlin, 1840, p. 20; Kütz. Bac. p. 98; Greg. Diat. of the Clyde, p. 9, pl. i. fig. 11; Ralfs, in Prit. Inf. p. 898; Rabenh. Europ. Diat. p. 183.
Pinnularia prætexta, Ehr. Mikrogeo. t. xix. fig. 28.

Plate II. fig. 1.

Frustule large. V. broad-oval; striæ coarse, granular, 8 to 10 in ·001″; marginal band narrow, with an inde-

finite inner border; median band narrow, close to the median line, and with an indefinite outer border; unstriated area broad, semilunate, and covered with irregularly scattered, conspicuous granules.

Hab. Marine. Lamlash Bay Isle of Arran, Loch Fyne (*Prof. Gregory*). Discovered by Ehrenberg in the clay-marl of Ægina, one of the oldest deposits in which the remains of diatomes have been found.

Navicula nebulosa, Gregory.

Navicula nebulosa, Greg. Diat. of the Clyde, p. 8, pl. i. fig. 8; Ralfs, in Prit. Inf. p. 898; Rabenh. Europ. Diat. p. 179.

Plate II. fig. 2.

V. oval, with a slight tendency to angularity in the middle, and to acumination at the apices; striæ fine, granular, rather faint; marginal band narrow, and of even width throughout; median band narrow, linear, and contiguous to the median line; unstriated area semilunate.

A much more finely striated species than *N. Hennedyii*.

Hab. Marine. Lamlash Bay Isle of Arran (*Prof. Gregory*).

Navicula Hennedyii, Smith.

Navicula Hennedyii, Sm. Synop. vol. ii. p. 93; Greg. Trans. Micr. Soc. vol. iv. pl. v. fig. 3; Ralfs, in Prit. Inf. p. 898, pl. vii. fig. 69; Rabenh. Europ. Diat. p. 178.

Plate II. fig. 3.

V. oval; striæ granular, distinct, about 24 in ·001″; marginal band with a crescentic inner border and gradually narrower towards the extremities, median band

tapering towards the central nodule; unstriated area narrow, lunate.

Hab. Marine. Frith of Clyde, January 1854 (*Mr. Hennedy*); Pool Bay (*Prof. Smith*); Lyme Regis (*Mr. Capron*); Glenshira sand and Lamlash Bay Isle of Arran (*Prof. Gregory*).

Navicula forcipata, Greville.

Navicula forcipata, Grev. Quart. Micr. Journ. vol. vii. p. 83, pl. vi. figs. 10 & 11; Ralfs, in Prit. Inf. p. 897; Rabenh. Europ. Diat. p. 178.

Plate II. fig. 4.

Frustule small. V. elliptical; striæ fine, granular, about 35 in ·001″; marginal band broad in the middle, gradually tapering towards the extremities, and having a bicrescentic inner border; median band contiguous to the median line, and with a convex outer border; unstriated area narrow, incurved at the extremities and middle; dry valve brown.

Hab. Marine. Lamlash Bay Isle of Arran (*Dr. Greville*); common on the sandy beach of the coast of Northumberland (*A. S. D.*); near Hull (*Mr. Norman*).

Navicula spectabilis, Gregory.

Navicula spectabilis, Greg. Diat. of the Clyde, p. 9, pl. i. fig. 10; Ralfs, in Prit. Inf. p. 898; Rabenh. Europ. Diat. p. 178.

Plate II. fig. 5.

Frustule large. V. broad, elliptical; striæ coarsely granular, about 22 in ·001″; marginal band with a doubly crescentic inner border, broad in the middle and gradually tapering towards the extremities, median

band linear, narrower towards the apices; unstriated area bilunate.

Hab. Marine. Lamlash Bay Isle of Arran and Loch Fyne (*Prof. Gregory*).

Navicula abrupta, Gregory.

Nivicula Lyra, var. *abrupta*, Greg. Diat. of the Clyde, p. 14, pl. i. fig. 14; Rabenh. Europ. Diat. p. 178.
Navicula lyra, Sm. Synop. vol. ii. p. 93, pl. xvii. fig. 152*a**.

Plate II. fig. 6.

V. elongated, oval; striæ grannular, about 24 in ·001″; marginal band broad in the middle, tapering towards the extremities, with a bicrescentic inner border, median band with a convex outer border; unstriated area narrow, incurved in the middle and at the extremities; dry valve colourless.

In some specimens the extremities of the unstriated longitudinal area reach near to the apices of the valve, in others they terminate *abruptly* some distance from them; in this respect considerable variation is observed.

I have, without hesitation, separated this form from *N. Lyra*, Ehren., with which it has been confounded, but from which it is essentially different; it never occurs with produced extremities, and the longitudinal unstriated area is always *incurved* towards its extremities, not *everted* as in *N. Lyra*.

Hab. Marine. Lamlash Bay Isle of Arran (*Prof. Gregory*); Poole Bay (*Prof. Smith*); Estuary of the river Coquet, Northumberland, plentiful (*A. S. D.*).

2. *Extremities produced.*

Navicula Lyra, Ehrenberg.

Navicula Lyra, Ehren. Amer. 1843, p. 131, t. I. i. fig. 9 *a*; Kütz. Bac. p. 94, t. xxviii. fig. 55; Spec. Alg. p. 74; Sm. Synop. vol. ii. p. 93; Greg. Diat. of the Clyde, p. 13, pl. i. fig. 13; Ralfs, in Prit. Inf. p. 897; Rabenh. Europ. Diat. p. 177.

Navicula Gregoriania, Grev. Quart. Micr. Journ. vol. v. p. 10, pl. iii. fig. 7.

Plate II. fig. 7.

V. linear, elliptical, with produced broad rounded extremities, or linear with cuneate or subcuneate extremities; striæ granular, 22 to 24 in ·001″; marginal band wide, and broadest in the middle; unstriated area narrow, linear, strongly incurved in the middle and everted towards the extremities, which reach to or near the margin of the valve.

In this species the marginal band of striæ is proportionately wider than in the other members of the present group; it is further distinguished by the double lyre-shaped blank space on the surface of the valve.

In the variety with cuneate apices, and in short stunted specimens generally, the longitudinal unstriated areas are frequently *straight* instead of *everted* towards their undeveloped extremities, which do not reach to the margin of the valve.

Hab. Marine. Salt Pans, Hampshire (*Prof. Smith*); Cumbrae (*Dr. Walker Arnott*); Isle of Arran and Loch Fyne (*Prof. Gregory*); Flamboro' Head (*Mr. Norman*); on the sandy beach, Northumberland, in several localities, abundant (*A. S. D.*).

Navicula clavata, Gregory.

Navicula clavata, Greg. Trans. Micr. Soc. vol. iv. p. 46, pl. v. fig. 17; Ralfs, in Prit. Inf. p. 898.
Navicula Lyra, Rabenh. Europ. Diat. p. 178.
Navicula Wrightii, O'Meara, Quart. Micr. Journ. vol. vii. n. s. p. 116, pl. v. fig. 4.

Plate II. fig. 8.

V. broadly elliptical, extremities produced, broad, and rounded; striæ granular; marginal band broad, and of equal width except near the extremities, where it is abruptly separated from the median band; unstriated area lunate, with everted narrow extremities reaching to the margin of the valve at the base of its apices.

Hab. Marine. Lamlash Bay Isle of Arran, Glenshira sand (*Prof. Gregory*); coast of Northumberland (*A. S. D.*).

Navicula rostrata, Ehrenberg.

Navicula rostrata, Ehren. Berlin, 1840, p. 18; Kütz. Bac. p. 94, t. iii. fig. 55; Ralfs, in Prit. Inf. p. 901; Rabenh. Süssw. Diat. p. 37, pl. vi. fig. 52, and Europ. Diat. p. 197.
Navicula tumens, Sm. Synop. vol. i. p. 52, pl. xvii. fig. 150; Ralfs, in Prit. Inf. p. 900; Rabenh. Europ. Diat. p. 192.
Navicula sculpta, Ehren. Mikrogeo. t. X. i. fig. 5; Ralfs, in Prit. Inf. p. 900.
Frustulia sculpta, Rabenh. Europ. Diat. p. 227.

Plate II. fig. 9.

V. elliptical, gradually attenuated into produced obtuse extremities; striæ slightly inclined, granular, about 36 in ·001″; marginal band broad, with an indefinite inner border, and much shortened in the middle, on one side of the valve; median band narrow, linear, and bordering the median line, which is narrow; unstriated area narrow sublunate, with indefinite margins.

There can be no doubt whatever that the synonyms of

this species are those given above. It is somewhat remarkable that it has been described as constituting three different species. The late Prof. Smith's description and figure of *N. tumens*, Sm., give a very inadequate idea of the arrangement of the striæ in this curious form; the peculiar arrangement is not easily observed, except with superior object-glasses and suitable illumination. I have carefully compared British specimens of this species with those of *N. rostrata*, Ehren., occurring in the Bergmehl of Santa Fiore, and with those of *N. sculpta*, Ehren., found in the fossil deposit from Franzensbad, and figured in the 'Mikrogeologie;' and I find them to be perfectly identical. The British and Santa-Fiore specimens are exactly alike, while those of *N. sclupta* from Franzensbad are larger and have the granular structure of the valve and the peculiar arrangement of the striæ much more strongly developed, so as to be distinctly visible even with a moderately low power. To this circumstance, and the imperfect instrument employed in 1840, in the description of *N. rostrata*, we may, perhaps, attribute the fact of Ehrenberg having described it as constituting two distinct species. Prof. Smith appears to have been unacquainted with *N. rostrata*.

Hab. Brackish water, Newhaven, Sussex (*Prof. Smith*); near Hull (*Mr. Norman*); near Liverpool (*Mr. Comber*); Salt Marsh, Warkworth, Northumberland (*A. S. D.*).

Subsection II. *Valve elliptical or oval, with produced, obtuse extremities; striæ not interrupted.*

Navicula granulata, De Brébisson.

Navicula granulata, Bréb. MS.; Donkin, Trans. Micr. Soc. vol. vi. p. 17, pl. iii. fig. 19; Ralfs, in Prit. Inf. p. 903; Rabenh. Europ. Diat. p. 201.

Plate III. fig. 1.

Frustule large. V. broad, elliptical or linear-elliptical, with produced, broad, rounded extremities (sometimes elongated and constricted in the middle); median line narrow; striæ reaching to the median line, somewhat shortened around the central nodule, convergent, coarse, and widely granular. Dry valve dullish blue.

Distinguished from *N. latissima* and *N. humerosa* by its much coarser striæ.

Hab. Marine. This large and beautiful species is very common in the sandy ripples of the sea-shore in many localities; but it does not occur in a living state in the tidal estuaries of our rivers.

Navicula latissima, Gregory.

Navicula latissima, Greg. Trans. Micr. Soc. vol. iv. n. s. p. 40, pl. v. fig. 4; Ralfs, in Prit. Inf. p. 903, pl. vii. fig. 70; Rabenh. Europ. Diat. p. 201.

Pinnularia divaricata, O'Meara, Quart. Micr. Journ. n. s. vol. vii. p. 116, pl. v. fig. 7.

Plate III. fig. 2.

Frustule large. V. broadly oval or elliptical; extremities slightly, not prominently, produced by a gentle constriction, broad and rounded; striæ distinctly gra-

nular, convergent, and of unequal length around the centre, reaching to the median line near the extremities, then gradually receding from it towards the central nodule, around which they leave an orbicular blank space.

Hab. Marine. Lamlash Bay Isle of Arran, Estuary of the Clyde, Glenshira sand (*Prof. Gregory*). This appears to be a deep-water species, not being found on the beach associated with *N. humerosa*.

Navicula humerosa, De Brébisson.

Navicula humerosa, Bréb. in Sm. Synop. vol. ii. p. 93; Ralfs, in Prit. Inf. p. 903; Rabenh. Europ. Diat. p. 201.
Navicula quadrata, Greg. Trans. Micr. Soc. n. s. vol. iv. p. 41, pl. v. fig. 5.
Navicula crassa, Greg. Quart. Micr. Journ. vol. iii. p. 41, pl. iv. fig. 18?

Plate III. fig. 3.

Frustule large. V. linear-elliptical, somewhat suddenly contracted into produced, broad, flattened apices; striæ very oblique, radiating around the centre, distinctly granular, about 25 in ·001″, reaching near to the median line, but shortened so as to leave a broad blank space opposite the central nodule. Dry valve colourless.

This species is very variable in size and outline. In elongated specimens it is frequently constricted in the middle; it is closely allied to *N. latissima* and *N. granulata*, but readily distinguished from it by its very much finer striæ, and by its outline near the extremities, which are much more produced.

Hab. Marine. Common on the sea-shore in the sandy ripples between tide-marks, and generally associated with *N. granulata*.

Navicula brevis, Gregory.

Navicula brevis, Greg. Diat. of the Clyde, p. 6, pl. i. fig. 4; Ralfs, in Prit. Inf. p. 899; Rabenh. Europ. Diat. p. 192.

Plate III. fig. 4.

Frustule small. V. short, broad, elliptical, slightly constricted into produced, broadly rounded extremities; striæ fine, about 35 in ·001″, slightly inclined, not reaching to the median line, and much shortened around the central nodule.

Hab. Marine. Lamlash Bay Isle of Arran (*Prof. Gregory*); Cumbrae (*Prof. Walker Arnott*).

Navicula marina, Ralfs.

Navicula marina, Ralfs, in Prit. Inf. p. 903; Rabenh. Europ. Diat. p. 202.
Navicula punctulata, Smith, Synop. vol. i. p. 52, pl. xvi. fig. 151.

Plate III. fig. 5.

V. broadly oval, with very slightly produced, rounded extremities; striæ reaching to the median line, oblique, convergent opposite the centre, about 32 in ·001″, distinctly granular.

Hab. Brackish water. Poole Bay and Seaford, Sussex (*Prof. Smith*). In brackish water near Hull, rare (*Mr. Norman*). Brackish water near Liverpool (*Mr. Comber*). Brackish water, estuary of R. Wansbeck, Northumberland, abundant (*A. S. D.*). Although this species is described as marine in the 'Synopsis' of Prof. Smith, I have never found it in purely marine localities, where its congener *N. granulata* is found.

Navicula pusilla, Smith.

Navicula pusilla, Sm. Synop. vol. i. p. 52, pl. xvii. fig. 145; Ralfs, in Prit. Inf. p. 900; Rabenh. Alg. Sub. no. 1185, and Europ. Diat. p. 193.
Navicula gastroides, Greg. Quart. Micr. Journ. vol. iii. p. 40, pl. iv. fig. 17.

Plate III. figs. 6*a* & 6*b*.

Frustule small. V. varying in outline, from suborbicular or broadly oval to elliptical-lanceolate, with produced, broad, truncate extremities; striæ reaching to the median line, radiating, granular, stouter, and more distant around the centre.

Hab. Fresh and slightly brackish water, frequent.

Navicula Carassius, Ehrenberg.

Navicula Carassius, Ehren. Amer. 1843, p. 130, t. II. ii. fig. 12; Kütz. Bac. p. 95, t. xxviii. fig. 67; Rabenh. Süssw. Diat. p. 40, t. vi. 57, and Europ. Diat. p. 193; Ralfs, in Prit. Inf. p. 900.
Navicula lacustris, Greg. Quart. Micr. Journ. vol. iv. p. 6, pl. i. 23, β; Ralfs, in Prit. Inf. p. 903; Rabenh. Europ. Diat. p. 200.

Plate III. fig. 7.

Frustule minute. V. elliptical, gradually attenuated into produced narrow obtuse extremities; striæ reaching to the median line, convergent towards the centre, distinct, granular.

A much smaller species than *N. pusilla*, with much finer striæ, and at once distinguished by its *narrow* produced apices.

Hab. Fresh water. River Coquet Northumberland (*A. S. D.*); Loch Leven (*Prof. Gregory*).

Navicula Semen, Ehrenberg.

Navicula Semen, Ehren. Amer. 1843, t. IV. ii. fig. 8; Kütz. Bac. p. 99, t. xxviii. fig. 49; Rabenh. Süssw. Diat. p. 38, t. v. fig. 2, and Europ. Diat. p. 194; Sm. Synop. vol. i. p. 50, pl. xvi. fig. 141; Ralfs, in Prit. Infus. p. 900.

Pinnularia Semen, Ehren. Mikrogeo. t. XIV. fig. 12, t. XVI. iii. fig. 26, t. XVII. ii. fig. 8?

Amphiprora navicularis, Ehren. Mikrogeo. t. III. i. fig. 10, 11, & iii. fig. 8, t. IV. ii. fig. 16, t. V. i. fig. 10.

Plate III. fig. 8.

V. oblong-elliptical or oval, slightly constricted into broad flattened extremities; striæ reaching to the median line, coarse, obscurely granular, convergent, stouter and more distant, but of equal length around the central nodule. Variable in size and outline.

It is difficult to say what species is meant by Ehrenberg as *Pinnularia Semen*, as different species are figured under this name in the 'Mikrogeologie,' one of these only being striated (t. xiv. fig. 12), and apparently identical with *Pin. Gastrum* (t. xv. A. fig. 23); the other figures are unstriated, and none of them are identical with *N. Semen* of Smith's Synopsis, which I have adopted as the genuine form, and which is identical with *Amphiprora navicularis*, Ehren. Mr. Ralfs describes the striæ of *N. Semen* as "*obsolete or apparent*," Prof. Smith as "*distinct*."

Hab. Fresh water, frequent. Peterhead deposit (*Prof. Smith*); near Hull (*Mr. Norman*); River Coquet Northumberland (*A. S. D.*).

Navicula inflata, Kützing.

Navicula inflata, var. β, Kütz. Bac. p. 99, t. iii. fig. 36, 3; Sm. Synop. vol. i. p. 50, pl. xvii. fig. 158; Rabenh. Europ. Diat. p. 191.

Pinnularia inflata, Rabenh. Süssw. Diat. p. 44, t. v. fig. 10*c*.

Plate III. fig. 9.

Frustule small. V. elliptical, extremities produced, broad

and flattened; striæ oblique, reaching to the median line, distinct, much coarser and more distant opposite the central nodule.

Hab. Fresh water. Lough Mourne deposit.

Navicula Gastrum, Ehrenberg.

Pinnularia Gastrum, Ehren. Amer. p. 133, t. III. vii. fig. 22, and Mikrogeo. t. V. i. fig. 12, t. XV. A. fig. 23; Rabenh. Süssw. Diat. p. 44, t. vi. fig. 15.

Navicula Gastrum, Kütz. Bac. p. 94, t. xxviii. fig. 56; Ralfs, in Prit. Inf. p. 900.

Navicula varians, Greg. Trans. Micr. Soc. vol. iii. n. s. p. 10, pl. ii. figs. 27, 28.

Plate III. fig. 10.

Frustule small. V. broad, elliptical, slightly constricted into broad flattened extremities; striæ coarse, costate, reaching to the median line, oblique and parallel, except opposite the central nodule, where they are transverse, shortened, and of unequal length.

Ehrenberg's figure in the 'Mikrogeologie,' of this species as it occurs in the Loch-Mourne deposit, is very characteristic. The figure in the present work also represents a specimen from the same deposit. It is easily recognized from *N. Semen* by the great difference in the character of its striæ in the middle of the valve.

Hab. Fresh water. Loch-Mourne deposit (*A. S. D.*); Scotland (*Prof. Gregory*).

Navicula cocconeiformis, Gregory.

Navicula cocconeiformis, Greg. Quart. Micr. Journ. vol. iv. p. 6, pl. i. fig. 22; Grev. Ann. & Mag. Nat. Hist. 2nd ser. vol. xv. pl. ix. fig. 6; Sm. Synop. vol. ii. p. 92; Ralfs, in Prit. Inf. p. 896; Rabenh. Europ. Diat. pp. 186 & 189.

Plate III. fig. 11.

Frustule small. V. broad, elliptical, and slightly con-

stricted near the broad rounded extremities; striæ slightly connivent, fine, and very delicate, 54 in ·001″, reaching to the median line.

Hab. Fresh water. Braemar (*Dr. Greville*); Elgin, Loch Leven, and other localities in Scotland (*Prof. Gregory*); River Coquet Northumberland, April 1869, abundant (*A. S. D.*).

Navicula hebes, Ralfs.

Navicula hebes, Ralfs, in Prit. Inf. p. 896; Rabenh. Europ. Diat. p. 189.
Navicula obtusa, Sm. Synop. vol. i. p. 50, pl. xvi. fig. 140.

Plate III. fig. 12.

Frustule small. V. somewhat convex, elongate, elliptical, constricted beneath the dilated, broadly rounded extremities; striæ sharp and distinct, about 35 in ·001″; nearly transverse, not reaching to the median line, and shortest around the central nodule. Colour pale brown.

Hab. Fresh water. Rassay Earth, Marl, Co. Down, Lough-Mourne deposit (*Prof. Smith*); Loch-Oich deposit, Caledonian Canal (*A. S. D.*).

Navicula elegans, Smith.

Navicula elegans, Sm. Synop. vol. i. p. 49, pl. xvi. fig. 137; Ralfs, in Prit. Inf. p. 907; Rabenh. Europ. Diat. p. 182.

Plate IV. fig. 1.

V. elliptical, attenuated towards the slightly produced, subacute or slightly obtuse extremities; striæ radiate and curved, reaching to the median line, but much shortened around the central nodule, distinct, costate, 24 in ·001″.

Hab. Brackish water: frequent. Pool Bay (*Prof. Smith*); Lancashire (*Mr. Johnston*); near Hull (*Mr. Norman*); R. Blyth, Northumberland (*A. S. D.*).

Navicula subsalina, Donkin.

Navicula Amphisbæna, var. β, Smith, Synop. vol. i. p. 51, pl. xvii. fig. 147β; Ralfs, in Prit. Inf. p. 899, pl. ix. fig. 141, *non* pl. vii. fig. 72; Rabenh. Europ. Diat. p. 191, confusa cum *N. Amphisbæna.*

Plate IV. fig. 2.

V. elliptical, or elliptical-lanceolate, with produced, obtuse extremities; striæ distinct, about 30 in ·001″, slightly oblique, shortened in the middle, and lengthened towards the extremities, so as to leave a broadly lanceolate median blank space.

This species has long been confounded with *N. Amphisbæna*, of which, on very insufficient grounds, it has been considered a variety peculiar to brackish water; it is, however, essentially different, in its much coarser striæ, in the outline of its extremities, and larger size, independently of habitat. The assertion of the late Prof. Walker Arnott (Quart. Micr. Journ. vol. vii. p. 176), that "*N. Amphisbæna* occurs in fresh water, brackish water, and in the sea" (this being the brackish-water, and *N. brevis*, Greg., the salt-water variety), appears to me to be purely *hypothetical.* By careful observation I have been unable to detect the slightest approximation towards an intermediate state between *N. Amphisbæna* and its *supposititious* varieties; consequently I have, without hesitation, separated the present species from it.

Hab. Brackish water: frequent.

PLATE I.

[All the Figures in the work are magnified 500 diameters, unless it is specially stated to the contrary.]

Fig. 1. Navicula hyalina, Donkin.

2. Navicula littoralis, Donkin.

3. Navicula æstiva, Donkin.

4. Navicula Smithii, De Brébisson.

5. Navicula fusca, Gregory.

6*a* & 6*b*. Navicula elliptica, Kützing.

7. Navicula nitescens, Gregory.

8. Navicula lineata, Donkin.

9. Navicula suborbicularis, Gregory.

10. Navicula pygmæa, Kützing.

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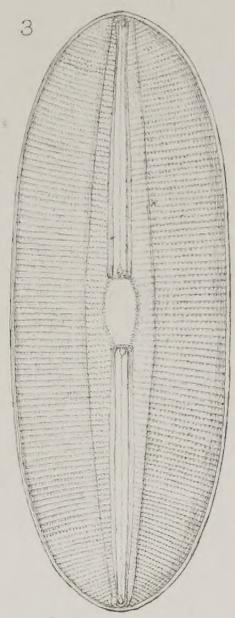
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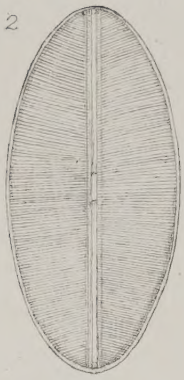
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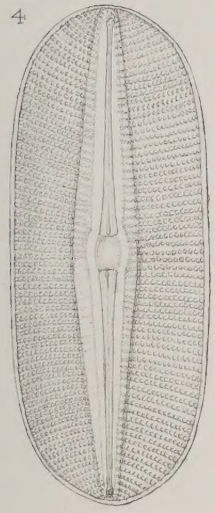
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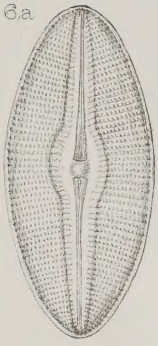
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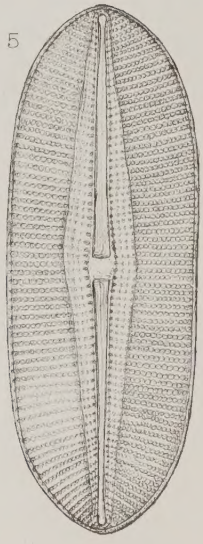
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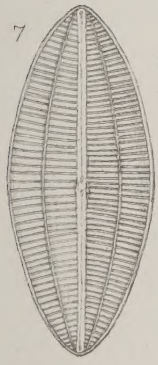
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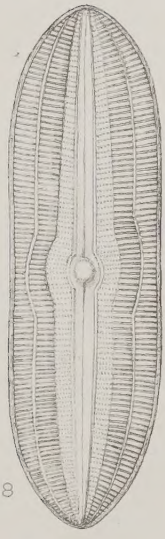
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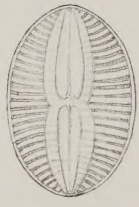
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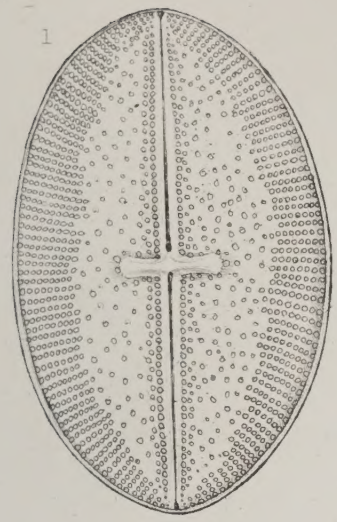
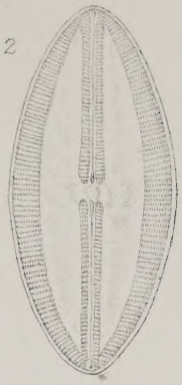
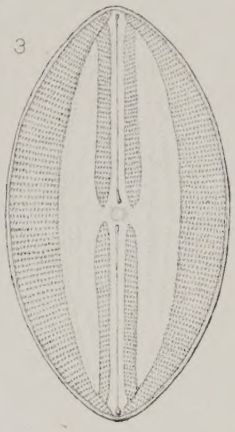
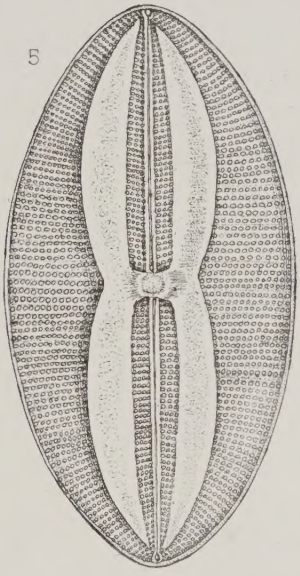
PLATE II.

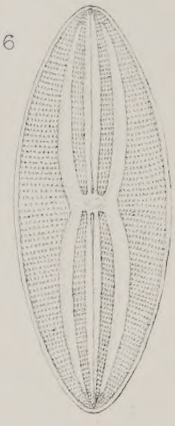
Fig. 1. Navicula prætexta, Ehrenberg.
2. Navicula nebulosa, Gregory.
3. Navicula Hennedyii, Smith.
4. Navicula forcipata, Greville.
5. Navicula spectabilis, Gregory.
6. Navicula abrupta, Gregory.
7. Navicula lyra, Ehrenberg.
8. Navicula clavata, Gregory.
9. Navicula rostrata, Ehrenberg.

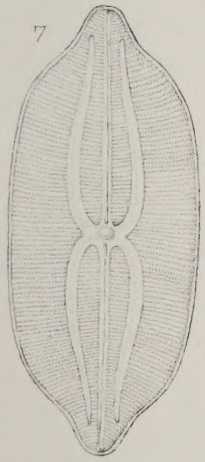












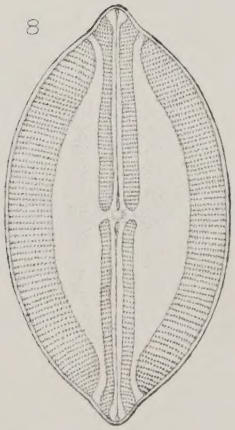


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PLATE III.

Fig. 1. Navicula granulata, De Brébisson.

2. Navicula latissima, Gregory.

3. Navicula humerosa, De Brébisson.

4. Navicula brevis, Gregory.

5. Navicula marina, Ralfs.

6*a* & *b*. Navicula pusilla, Smith.

7. Navicula Carassius, Ehrenberg.

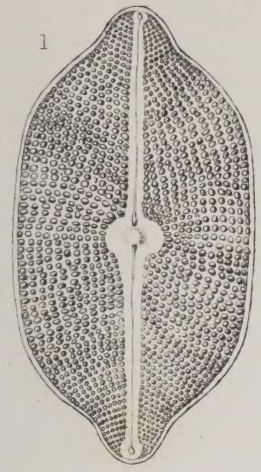
8. Navicula Semen, Ehrenberg.

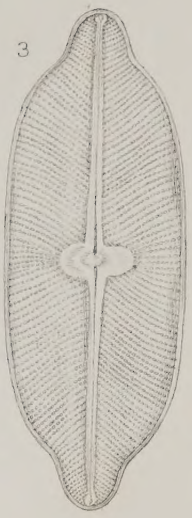
9. Navicula inflata, Kützing.

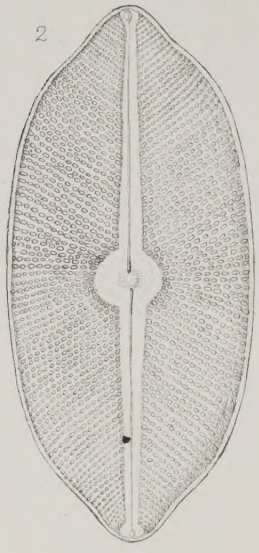
10. Navicula Gastrum, Ehrenberg.

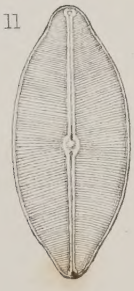
11. Navicula cocconeiformis, Gregory.

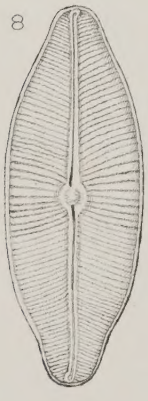
12. Navicula hebes, Ralfs.











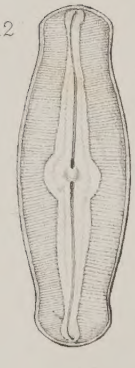


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PLATE IV.

Fig. 1. Navicula elegans, Smith.

2. Navicula subsalina, Donkin.

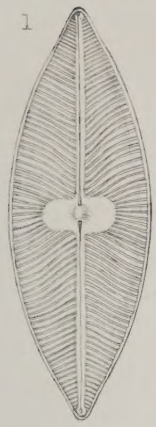
3. Navicula palpebralis, De Brébisson. *a*, the typical form; *b*, var. in which the median blank space is lanceolate, and the striæ opposite the central nodule slightly shortened.

4. Navicula angulosa, Gregory.

5. Navicula semiplena, Greville.

6. Navicula alpina, Smith. *a*, S.V.; *b*, M.V.

7. Navicula latiuscula, Kützing.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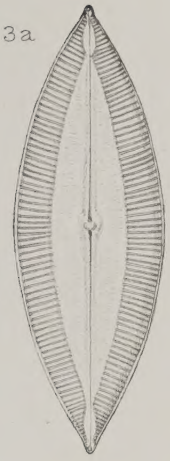
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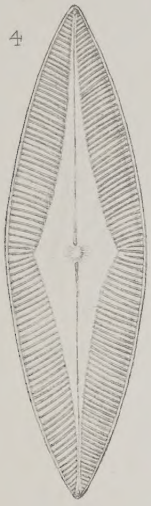
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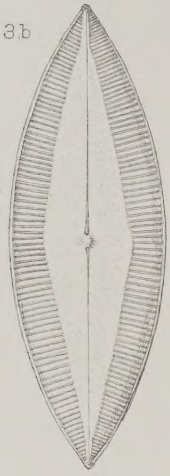
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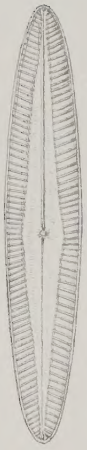
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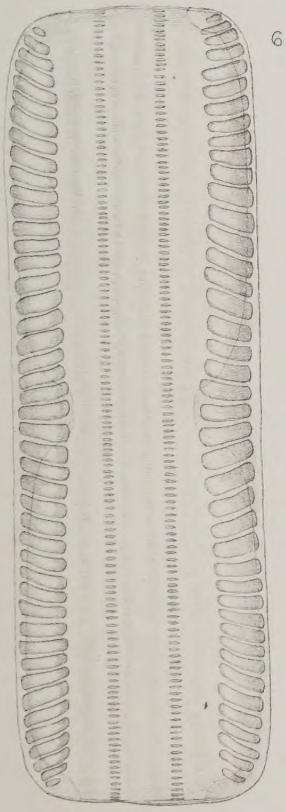
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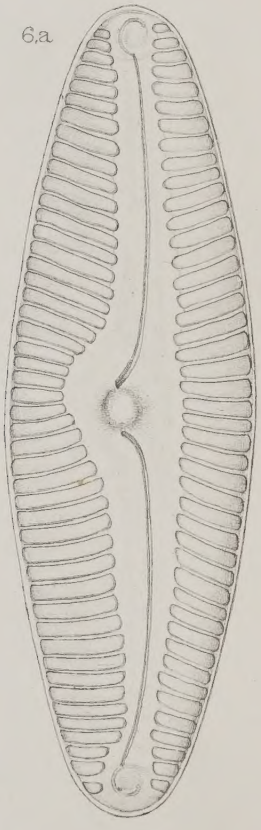
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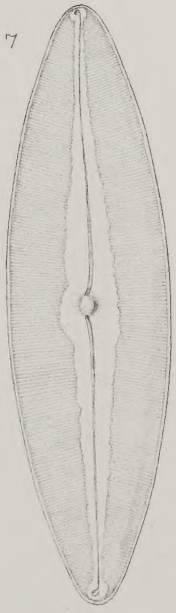
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THE NATURAL HISTORY

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ARTHUR SCOTT DONKIN, M.D.

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UNIVERSITY OF TORONTO

Navicula maculosa, Donkin, n. sp.

Plate V. fig. 1.

Frustule small. V. linear-elliptical, constricted into produced, narrow, tapering, obtuse or subacute apices; striæ somewhat coarse, distinctly granular, oblique, connivent, reaching to the median line, but shortened around the central nodule; dry valve of leaden-blue colour.

This species, in outline, resembles *N. apiculata*, Bréb., but is essentially different in the flatness of its valve and in the character of its striæ, the granules of which are large and distinctly segregated, like those of *N. granulata*, Bréb., to which it is allied.

Hab. Marine; generally associated with *N. humerosa*, Bréb. Linemouth, Northumberland; coast of Jersey (*A. S. D.*).

Subsection III. *Valve oblong-elliptical, or elliptical-lanceolate; extremities rounded or acute; striæ uninterrupted, not reaching to the median line.*

Navicula palpebralis, De Brébisson.

Navicula palpebralis, Bréb. in Sm. Synop. vol. i. p. 50, pl. xxxi. fig. 273; Ralfs, in Prit. Inf. fig. 905; Rabenh. Europ. Diat. p. 182.
Navicula Barclayana, Greg. Diat. of the Clyde, p. 8, pl. 1. fig. 9; Ralfs, in Prit. Inf. p. 903; Rabenh. Europ. Diat. p. 201.

Plate IV. figs. 3*a* & 3*b*.

V. elliptical-lanceolate, extremities acute and slightly mucronate; striæ marginal and of nearly equal length (leaving an elliptical, or elliptical-lanceolate, median blank space), oblique, subparallel, costate, about 22 in ·001″.

This species is very variable in size and outline.

Hab. Marine. By far the most abundant of the littoral *Naviculæ*; it is generally found in suitable localities, on the sandy beach, during the summer months, so that a sand-gathering can scarcely be made without obtaining it. The specimens sent to me from the sands at Dives in Normandy by M. De Brébisson are exactly similar to those found on the Northumbrian shore; so also are those of *N. Barclayana* of Prof. Gregory, sent by him to me from the estuary of the Clyde.

Navicula angulosa, Gregory.

Navicula angulosa, Greg. Trans. Micr. Soc. n. s. vol. iv. p. 42, pl. v. fig. 8; Ralfs, in Prit. Inf. p. 905; Rabenh. Europ. Diat. p. 176.

Plate IV. fig. 4.

V. elliptical-lanceolate, extremities subacute; striæ oblique, marginal, elongated towards the extremities, shortened and angular in the middle, stout, costate, about 20 in ·001″; median blank space lanceolate with incurved sides.

Hab. Marine: littoral. Glenshira sand, estuary of the Clyde (*Prof. Gregory*); coast of Northumberland, abundant in localities where there is a *slight* admixture of fresh water (*A. S. D.*).

Navicula semiplena, Greville.

Pinnularia semiplena, Grev. Quart. Micr. Journ. vol. vii. p. 84, pl. vi. fig. 12.
Navicula angulosa, var. β, Greg. Trans. Micr. Soc. n. s. vol. iv. p. 42, pl. v. fig. 8*.

Plate IV. fig. 5.

V. linear-elliptical, or elliptical-lanceolate, extremities sub-

acute; striæ lengthened towards the extremities and shortened in the middle (so as to leave a lanceolate blank median space), distant, oblique, costate, about 15 in ·001″.

Hab. Marine. Lamlash Bay Isle of Arran, Glenshira sand (*Prof. Gregory*).

Navicula alpina, Smith.

Pinnularia alpina, Smith, Synop. vol. i. p. 55, pl. xviii. fig. 168; Rabenh. Europ. Diat. p. 213.
Navicula alpina, Ralfs, in Prit. Inf. p. 906.

Plate IV. fig. 6.

Frustule large, on M. V. linear with truncate extremities. V. oblong-elliptical, or elliptical-lanceolate, with rounded extremities; central nodule depressed; striæ shortened around the central nodule, radiate, distant, broad and costate, about 6 or 7 in ·001″.

The M. V. of this species is conspicuous from the two longitudinal, parallel lines of transversely elongated granules observable on the connecting zone.

Hab. Fresh water, subalpine. Aberdeenshire (*Dr. Dickie*); Ben M'Dhui (*Mr. P. Grant*); Loch-Oich deposit, Caledonian Canal; Cheviots, Northumberland (*A. S. D.*).

Navicula latiuscula, Kützing.

Navicula latiuscula, Kütz. Bac. p. 93, t. v. fig. 40; Ralfs, in Prit. Inf. p. 905; Rabenh. Süssw. Diat. p. 38, t. vi. fig. 61, and Europ. Diat. p. 182.
Navicula patula, Sm. Synop. vol. i. p. 49, pl. xvi. fig. 139.

Plate IV. fig. 7.

Frustule large. V. oblong-elliptical, or elliptical-lanceo-

late, with rounded extremities; striæ slightly oblique, close, and delicate, 36 in ·001″.

This species and the preceding are frequently found associated in subalpine localities, especially in lacustrine habitats. Both are abundant in a lacustrine deposit from Loch Oich on the Caledonian Canal, supplied to me by Mr. Hennedy.

Hab. Fresh water. North-west of Scotland, frequent; Loch-Oich deposit, Caledonian Canal (*A. S. D.*); Marl, Co. Down (*Prof. Smith*).

Subsection IV. *Valve oblong, linear-elliptical, or linear, with rounded or cuneate extremities; striæ fine, transverse, reaching to the median line.*

Navicula lævissima, Kützing.

Navicula lævissima, Kütz. Bac. p. 96, t. xxi. fig. 14; Ralfs, in Prit. Inf. p. 895; Sm. Synop. vol. ii. p. 91; Rabenh. Europ. Diat. p. 188.

Stauroneis rectangularis, Greg. Quart. Micr. Journ. vol. ii. p. 99, pl. iv. fig. 17.

Plate V. fig. 2.

Frustule small. V. hyaline, colourless, linear, sometimes slightly inflated in the middle, extremities flattened and slightly rounded; striæ fine, delicate, about 50 in ·001″, transverse, reaching to the median line; median line and nodules distinct.

The appearance of a *stauros*, as delineated in Prof. Gregory's figure, observable on this species when seen by a medium magnifying-power, is deceptive; the striæ reach to the central nodule.

Hab. Fresh water: frequent.

Navicula dirhynchus, Ehrenberg.

Navicula dirhynchus, Ehren. Amer. p. 131, t. III. i. fig. 11; Kütz. Bac. p. 95, t. xxviii. fig. 48; Rabenh. Süssw. Diat. p. 40, t. vi. fig. 48; Ralfs, in Prit. Inf. p. 901.
Navicula rhynchocephala, Kütz., *var. parva*, Rabenh. Europ. Diat. p. 196.

Plate V. fig. 3.

Frustule small. V. hyaline, nearly linear, with a slight constriction beneath the obtuse extremities; striæ inconspicuous; median line dark and conspicuous; terminal nodules not reaching to the apices.

In outline this species has a strong resemblance to *N. affinis*; but it is much smaller, and distinguished by the apparent absence of striæ.

Hab. Fresh water. R. Coquet Northumberland: frequent (*A. S. D.*).

Navicula Hitchcockii, Ehrenberg.

Navicula Hitchcockii, Ehren. Amer. p. 130; Mikrogeo. t. V. iii. fig. 11; Kütz. Bac. p. 101; Ralfs, in Prit. Inf. p. 894, pl. vii. fig. 62.

Plate V. fig. 4.

V. oblong, linear, margins triundulate, extremities cuneate, slightly incurved, acute; striæ fine, transverse, reaching to the median line and central nodule.

Hab. Fresh water. Loch-Oich deposit, Caledonian Canal (*A. S. D.*). I can find no notice of this species having been previously discovered in Europe.

Navicula dubia, Ehrenberg.

Navicula dubia, Ehren. Amer. 1843, p. 130, t. II. ii. fig. 8; Kütz. Bac. p. 96, t. xxviii. fig. 61; Rabenh. Süssw. Diat. p. 40, t. vi. fig. 60; Greg. Quart. Micr. Journ. vol. iv. p. 3, pl. i. fig. 3; Ralfs, in Prit. Inf. p. 902.

Navicula Peisonis, Grunow, in Wien. Verh. 1860, p. 544, t. i. fig. 28; Rabenh. Europ. Diat. p. 202.

Plate V. fig. 5.

Frustule small. V. linear, with slightly produced, narrow, obtuse, or subacute, extremities; margins straight, or slightly triundulate; striæ fine, delicate, transverse, reaching to the median line and crossed, near the margin, by a longitudinal line.

Distinguished from *N. affinis* by its much smaller size, finer striæ, and suddenly produced, narrow extremities.

Hab. Fresh water. Elgin and Loch Leven, Scotland (*Prof. Gregory*); River Coquet Northumberland (*A. S. D.*).

Navicula Iridis, Ehrenberg.

Navicula Iridis, Ehren. Amer. 1843, p. 130, t. IV. i. fig. 2; Kütz. Bac. p. 92, t. xxviii. fig. 42; Ralfs, in Prit. Inf. p. 907; Rabenh. Europ. Diat. p. 171.

Pinnularia Iridis, Rabenh. Süssw. Diat. p. 42, t. vi. fig. 1.

Navicula firma, Sm. Synop. vol. i. p. 48, pl. xvi. fig. 138.

Plate V. fig. 6.

Frustule large, on M.V. linear, with rounded extremities. V. linear or linear-elliptical, with rounded extremities and conspicuous terminal nodules; striæ fine, about 35 in ·001″, transverse, reaching to the median line, shortened opposite the central nodule, and interrupted near the margin by a series of wavy longitudinal lines. Colour brownish, iridescent.

This is a distinct and well-marked species, although by

some observers considered a *variety* of *N. firma*. I have found it in a living state in gatherings associated with the latter, with *N. affinis* and *N. amphirhynchus*.

Hab. Fresh water: frequent. River Coquet Northumberland (*A. S. D.*).

Navicula firma, Kützing.

Navicula firma, Kütz. Bac. p. 92, t. xxi. fig. 10; Ralfs, in Prit. Inf. p. 909.
Navicula firma, var. β and γ, Sm. Synop. vol. i. p. 48, and vol. ii. p. 90.
Navicula amphigomphus, Ehren. Amer. 1843, p. 129, t. III. i. fig. 8, and Mikrogeo. numer. figs.; Kütz. Bac. p. 93, t. xxviii. figs. 40 & 41; Rabenh. Süssw. Diat. p. 38, t. vi. fig. 47, and Europ. Diat. p. 176; Ralfs, in Prit. Inf. p. 908.
Pinnularia amphigomphus, Ehren. Amer. t. II. i. fig. 27, and Mikrogeo. t. xiv. fig. 11?
Navicula dilatata, Ehren. Amer. 1843, p. 130, and Mikrogeo. numer. figs.; Kütz. Bac. p. 99; Rabenh. Süssw. Diat. p. 37, and Europ. Diat. p. 173; Ralfs, in Prit. Inf. p. 908.
Navicula affinis, var. b, Rabenh. Europ. Diat. p. 196, and *var.* β. *amphirhynchus*, Grunow, in Wien. Verh. 1860, p. 544, t. iii. fig. 5.
Navicula pannonica, Grunow, in Wien. Verh. 1860, p. 541, t. ii. fig. 40, and Rabenh. Europ. Diat. p. 174?

Plate V. fig. 7.

V. linear, with cuneate, subacute, or obtuse extremities, or linear-elliptical, attenuated towards the obtuse extremities; striæ fine, granular, about 40 in ·001″, transverse, reaching to the median line, shortened opposite the central nodule, and interrupted by longitudinal wavy lines near the margin; colour brownish.

In consequence of being subject to considerable variation in outline, the position of this species is in a state of great confusion. Kützing's typical form was found in the well-known fossil diatomaceous earth from Santa Fiore in Italy; as it occurs in this deposit its outline is almost linear, with cuneate, obtuse, or subacute, extremities. Ehrenberg,

however, had elevated into a species that form of it in which the linear margins and cuneate extremities are most prominent, and into another species the other variety, in which the middle of the valve is more tumid or elliptical; the former he named *N. amphigomphus*, the latter *N. dilatata*. Between these two forms, however, every degree of gradation is observable; consequently both are synonymous with Kützing's type. The late Prof. Smith unfortunately, in his 'Synopsis' (*loc. cit.*), described and figured *N. Iridis*, Ehren., as the typical *N. firma*, and referred Kützing's original type to it as a *variety*, as well as the *N. amphigomphus* of Ehrenberg. Rabenhorst (Europ. Diat. *loc. cit.*) first refers *N. firma*, Kütz., to *N. affinis*, Ehren., as a *var.*, and afterwards places it amongst the fossil and extra-European species, referring to it as "*fossilis in Italia*" (p. 226). Should *Pinnularia amphigomphus*, Ehren. (Mikrogeo.), on further investigation prove to be a species distinct from *N. firma*, its specific appellation must be retained.

Navicula microstoma, Kützing, is synonymous with his *Nav. lata* (Bac. p. 92, t. iii. fig. 51); and although considered by Rabenhorst to be identical with *N. firma*, it is evidently a distinct species. It is distinguished by its larger size and very turgid middle tapering to the subacute extremities, as well as by the series of longitudinal lines crossing the striæ being placed about midway between the median line and the margin. To this species should be referred the fine large form occurring in several diatomaceous deposits from the United States; of this Mr. Kitton has given a figure and description ('Science Gossip,' April 1867, p. 156, fig. 153). The American specimens are very large and beautiful, especially those in my possession from the Cherryfield deposit.

Hab. Fresh water: frequent.

Navicula affinis, Ehrenberg.

Navicula affinis, Ehren. Amer. 1843, p. 129, t. II. ii. fig. 7, II. iii. fig. 2, II. iv. fig. 4, II. v. fig. 4, III. iii. fig. 8, IV. ii. fig. 6, and IV. v. fig. 10; Kütz. Bac. p. 95, t. xxviii. fig. 65, and t. xxx. figs. 45 & 46; Sm. Synop. vol. i. p. 50, pl. xvi. fig. 143; Ralfs, in Prit. Inf. p. 902, pl. xii. fig. 32; Rabenh. Süssw. Diat. p. 40, t. vi. fig. 58, and Europ. Diat. p. 196.

Navicula ampliata, Ehren. Mikrogeo. t. xv. figs. 32 & 35.

Navicula liber, var. β, Roper, Quart. Micr. Journ. vol. vi. p. 25, pl. iii. fig. 10.

Plate V. fig. 8.

V. linear, or linear-elliptical, with a gently incurved constriction beneath the rounded extremities; striæ fine, about 46 in ·001″, transverse, reaching to the median line, shortened opposite the central nodule, and interrupted by a longitudinal line near to and parallel with the margin.

Distinguished from *N. firma* by its much smaller size, incurved constriction near the apices, and finer striæ; this species is not subject to much variation. I cannot agree with Rabenhorst that it is the type to which *N. firma* and *N. amphirhynchus* should be referred as varieties, although these species and *N. Iridis* are closely allied, and present a great similarity in the structure of their valves.

Hab. Fresh water: common.

Subsection V. *Valve suddenly constricted into produced, capitate, subcapitate, linear, or mucronate extremities.*

The species included in this subsection are readily distinguished from those of Subsection II. by the *sudden*, and generally deep, constriction of the valve into produced extremities; in the latter the constriction is always *gradual and tapering* and in some instances very slight. Both subsections form very natural groups; and it is essential for

the easy identification of species that they should be separated from each other.

A. *Extremities capitate or subcapitate.*

1. *Valve elliptical.*

Navicula amphirhynchus, Ehrenberg.

Navicula amphirhynchus, Ehren. Amer. 1843, p. 129, t. III. i. fig. 10 &c.; Kütz. Bac. p. 95, t. iv. fig. 13, t. xxi. fig. 11, and t. xxviii. fig. 47; Rabenh. Süssw. Diat. p. 40, t. vi. fig. 50; Sm. Synop. vol. i. p. 51, pl. xvi. fig. 142; Ralfs, in Prit. Inf. p. 901, pl. xii. fig. 6.

Navicula producta, Smith, Synop. vol. i. p. 51, pl. xvii. fig. 144; Ralfs, in Prit. Inf. p. 902, pl. vii. fig. 66; Grunow, in Wien. Verh. 1860, p. 543, t. ii. fig. 35.

Navicula affinis, var. c, Rabenh. Europ. Diat. p. 196, *var. a. genuina*, Grunow, in Wien. Verh. 1860, p. 543, t. iii. figs. 2*a* & *b*, & 3.

Plate V. fig. 9.

V. elliptical or linear, with produced capitate extremities; striæ fine, distinct, granular, about 40 in ·001″, transverse in the middle, oblique towards the extremities, reaching to the median line, slightly shortened opposite the central nodule, and interrupted midway between the median line and the margin by one or more undulating longitudinal lines. Dry valve yellowish brown.

Hab. Fresh water: frequent.

Navicula sphærophora, Kützing.

Navicula sphærophora, Kütz. Alg. exs. no. 84, Bac. p. 95, t. iv. fig. 17; Sm. Synop. vol. i. p. 52, pl. xvii. fig. 148; Rabenh. Süssw. Diat. p. 40, t. vi. fig. 65*a*, and Europ. Diat. p. 191; Ralfs, in Prit. Inf. p. 899.

Plate V. fig. 10.

V. elliptical-lanceolate, deeply constricted into produced,

capitate apices; striæ reaching to the median line, transverse in the middle, slightly oblique near the extremities, fine, granular, about 40 in ·001″.

Rabenhorst, in comparing this species with *N. Amphisbæna*, observes "Nihilo minus ejus varietas esse mihi videtur." He describes it as having convergent transverse and very delicate longitudinal striæ; the latter, however, have no existence. It is a well-marked species, quite distinct from *N. Amphisbæna*, and is by no means so common or generally distributed. I have never met with it in the North of England, where the latter species is common; nor can I find any record of its occurrence in Scotland. By the kindness of Mr. T. Eulenstein I have been favoured with fine typical specimens from Stuttgart in Germany; it forms one of his beautiful series of typical species, so highly deserving the attention of microscopists.

Hab. Fresh water: not common. Lewes (*Prof. Smith*); near Hull, rare (*Mr. Norman*).

Navicula anglica, Ralfs.

Navicula anglica, Ralfs, in Prit. Inf. p. 900; Rabenh. Europ. Diat. p. 193.
Navicula tumida, Sm. Synop. vol. i. p. 53, pl. xvii. fig. 146.

Plate V. figs. 11*a* & 11*b*.

Frustule small. V. elliptical, deeply constricted into produced, short, capitate apices; striæ connivent, conspicuous, obscurely granular, 24 in ·001″, reaching to the median line.

Hab. Fresh water. Bramley near Guildford, Nov. 1850 (*Mr. Capron*); near Hull, rare (*Mr. Norman*); near Liverpool (*Mr. Comber*).

Navicula punctata, Kützing.

Stauroneis punctata, Kütz. Bac. p. 106, t. xxi. fig. 9; Sm. Synop. vol. i. p. 61, pl. xix. fig. 189; Ralfs, in Prit. Inf. p. 912; Rabenh. Europ. Diat. p. 245.
Stauroptera punctata, Rabenh. Süssw. Diat. p. 50, t. ix. fig. 11.

Plate V. fig. 12.

V. elliptical, deeply constricted into produced, capitate apices; striæ conspicuous, granular, about 27 in ·001″, oblique, reaching to the median line, shortened opposite to the central nodule, so as to leave a stauroneiform, median, blank space.

This species has been placed in the genus *Stauroneis* by Kützing, on account of the peculiar shortening of the striæ opposite the central nodule; it is, however, a genuine *Navicula*, belonging to the present group.

Hab. Fresh water: frequent in clear streams. River Coquet Northumberland, April and May (*A. S. D.*).

Navicula Amphisbæna, Bory de St. Vincent.

Navicula Amphisbæna, Bory, Encycl. Méthod. 1824; Turp. Dict. cl. t. I. 2. figs. 2 & 9; Ehren. Inf. 1838, p. 178, t. xiii. fig. 7; Kütz. Bac. p. 95, t. iii. figs. 41 & 42; Rabenh. Süssw. Diat. p. 40, t. vi. fig. 66, and Europ. Diat. p. 191; Sm. Synop. vol. i. p. 51, pl. xvii. fig. 147; Ralfs, in Prit. Inf. p. 899, pl. vii. fig. 72.
Navicula ventricosa, Ehren. Abhandlg. d. Berl. Ac. 1830, p. 67.
Frustulia depressa, Kütz. Synops. p. 21, fig. 27, Alg. ag. dulc. Dec. 8, 1833.

Plate V. fig. 13.

V. broad, elliptical, deeply constricted into produced, rotund, capitate apices; striæ fine, close, about 40 in ·001″, oblique and slightly curved, reaching to the median line near the extremities, gradually shortened towards the middle of the valve, so as to leave a

broadly lanceolate, median, blank space. Colour yellowish brown.

Hab. Fresh water: common.

Navicula cryptocephala, Kützing.

Navicula cryptocephala, Kütz. Bac. p. 95, t. iii. figs. 20 & 26; Sm. Synop. vol. i. p. 53, pl. xvii. fig. 155; Rabenh. Süssw. Diat. p. 39, t. vi. fig. 71, and Europ. Diat. p. 198; Ralfs, in Prit. Inf. p. 901.

Plate V. fig. 14.

Frustule minute. V. elliptical-lanceolate, deeply constricted into produced, short, capitate apices; striæ faint, 56 in ·001″, transverse, reaching to the median line.

Hab. Fresh water. Frequent in mountain-streams. R. Coquet Northumberland, May (*A. S. D.*).

Navicula undosa, Ehrenberg.

Navicula undosa, Ehren. Amer. p. 131, t. II. ii. fig. 10, Mikrogeo. t. XXXIX. iii. fig. 90; Kütz. Bac. p. 101, t. xxviii. fig. 83; Rabenh. Süssw. Diat. p. 41, t. vi. fig. 56, and Europ. Diat. p. 209; Ralfs, in Prit. Inf. p. 895.
Navicula quinquenodis, Grunow, in Wien. Verh. 1860, p. 522, t. i. fig. 33.

Plate VI. fig. 1.

Frustule small. V. broad, short, elliptical; margins triundulate; extremities produced, broad, subcapitate; striæ transverse, indistinct.

Hab. Fresh water: not common. Near Hull (*Mr. Norman*); Whissonsett, Norfolk (*Mr. Kitton*).

2. *Valve sublinear, with a median sinuous constriction.*

Navicula incurva, Gregory.

Navicula incurva, Greg. Quart. Micr. Journ. vol. iv. p. 8, pl. i. fig. 26; Ralfs, in Prit. Inf. p. 893; Rabenh. Europ. Diat. p. 203.
Navicula? Biblarium?, Ehren. Mikrogeo. t. XVII. i. figs. 8 & 9?

Plate VI. fig. 2.

Frustule small. V. hyaline, oblong, with incurved margins, and produced, broad, subcapitate extremities; striæ obscure.

Hab. Fresh water. River Findhorn, Loch Leven, Scotland (*Prof. Gregory*).

Navicula binodis, Ehrenberg.

Navicula binodis, Ehren. Abh. Berl. 1840, p. 18; Kütz. Bac. p. 100, t. iii. fig. 35; Rabenh. Süssw. Diat. p. 41, t. v. fig. 5, and Europ. Diat. p. 203; Sm. Synop. vol. i. p. 53, pl. xvii. fig. 159; Ralfs, in Prit. Inf. p. 893.
Fragillaria? binodis, Ehren. Amer. 1843, p. 127.

Plate VI. fig. 3.

Frustule minute. V. oblong, divided into two suborbicular lobes by a median sinuous constriction; extremities produced, narrow, nearly linear, obtuse; striæ obscure.

Hab. Fresh water: frequent.

3. *Valve lanceolate.*

Navicula rhynchocephala, Kützing.

Navicula rhynchocephala, Kütz. Bac. t. xxx. fig. 35; Sm. Synop. vol. i. p. 47, pl. xvi. fig. 132; Ralfs, in Prit. Inf. p. 900, pl. vii.

fig. 68; Rabenh. Süssw. Diat. p. 39, t. vi. fig. 68, and Europ. Diat. p. 196.

Plate VI. fig. 4.

Frustule small. V. elliptical-lanceolate, attenuated into produced, capitate extremities; striæ coarse, costate, about 24 in ·001″, connivent, reaching to the median line.

Hab. Fresh water: common.

Navicula ambigua, Ehrenberg.

Navicula ambigua, Ehren. Amer. 1843, p. 129, t. II. ii. fig. 9, and Mikrogeo. t. xv. B. fig. 15; Kütz. Bac. p. 95, t. xxviii. fig. 66, Spec. Alg. p. 75; Sm. Synop. vol. i. p. 51, pl. xvi. fig. 149; Ralfs, in Prit. Inf. p. 902; Rabenh. Süssw. Diat. p. 40, t. vi. fig. 59, and Europ. Diat. p. 192.

Plate VI. fig. 5.

V. broadly elliptical-lanceolate with produced, narrow, capitate extremities; striæ fine, delicate, 36 in ·001″, transverse, reaching to the median line.

Hab. Fresh water: frequent.

Navicula cuspidata, Kützing.

Navicula cuspidata, Kütz. Bac. p. 94, t. iii. figs. 24 & 37; Sm. Synop. vol. i. p. 47, pl. xvi. fig. 131; Ralfs, in Prit. Inf. p. 905, pl. xii. fig. 5; Rabenh. Süssw. Diat. p. 37, t. v. fig. 16, and Europ. Diat. p. 170.

Plate VI. fig. 6.

V. broadly lanceolate, tapering into slightly produced, subcapitate apices; striæ fine, delicate, 36 in ·001″, transverse, reaching to the median line.

Hab. Fresh water: common.

B. *Extremities linear or mucronate.*

Navicula Rostellum, Smith.

Navicula Rostellum, Sm. Synop. vol. ii. p. 93; Ralfs, in Prit. Inf. p. 900; Rabenh. Europ. Diat. p. 195.
Navicula apiculata, Greg. Quart. Micr. Journ. vol. iv. p. 4, pl. i. fig. 13.

Plate VI. fig. 7.

Frustule small. V. broadly elliptical-lanceolate, suddenly constricted into produced, linear, short, obtuse apices; striæ indistinct, 80 in ·001″.

Hab. Fresh water. Grasmere, Aug. 1853 (*Prof. Smith*); Falls of Tummel, July 1854 (*Dr. Greville*); Mull earth, Elgin, &c. (*Prof. Gregory*).

Navicula integra, Smith.

Pinnularia integra, Sm. Synop. vol. ii. p. 96; Rabenh. Europ. Diat. p. 220.
Pinnularia rostrata, Greg. Quart. Micr. Journ. vol. iv. p. 4, pl. i. fig. 14.
Navicula integra, Ralfs, in Prit. Inf. p. 895.

Plate VI. fig. 8.

Frustule minute. V. elliptical-lanceolate, slightly inflated in the middle and suddenly constricted into produced, mucronate apices; striæ fine, indistinct, reaching to the median line, stouter and more distant around the central nodule.

Hab. Fresh water. Powmouth Ayrshire (*Prof. W. Arnott*); various localities in Scotland (*Prof. Gregory*); River Coquet Northumberland (*A. S. D.*).

Subsection VI. *Valve lanceolate; striæ fine, transverse, or slightly oblique, reaching to the median line.*

Navicula fulva, Nitzsch.

Frustulia fulva, Nitzsch (ex parte), Breitäge, p. 87, t. iii. fig. 19 (1817).
Navicula fulva, Ehren. Inf. 1838, p. 177, t. xiii. fig. 6, Mikrogeo. numer. figs.; Rabenh. Süssw. Diat. p. 37, t. v. fig. 17, and t. vi. fig. 62.
Navicula cuspidata, Kütz. Bac. p. 94; Ralfs, in Prit. Inf. p. 905. *var.* Rabenh. Europ. Diat. p. 170.

Plate VI. fig. 9.

V. lanceolate, slightly constricted beneath the obtuse extremities; striæ slightly oblique, fine, about 30 in ·001″.

After a very careful comparison of this form with *N. cuspidata*, Kütz., which it closely resembles in general outline, I have considered it necessary to reestablish it as a species by separating it from the latter, from which it differs essentially in its smaller, narrower, and yellowish-brown-coloured valve, with unproduced extremities, coarser and distinctly oblique striæ.

Hab. Fresh water in subalpine localities. Loch-Oich deposit (*A. S. D.*).

Navicula serians, De Brébisson.

Navicula serians, Bréb. in Kütz. Bac. p. 92, t. xxx. fig. 23; Rabenh. Süssw. Diat. p. 38, t. vi. fig. 51, and Europ. Diat. p. 172; Sm. Synop. vol. i. p. 47, pl. xvi. fig. 130; Ralfs, in Prit. Inf. p. 904.
Navicula lineolata, Ehren. Amer. 1843, t. I. iii. fig. 4, t. II. vi. fig. 27, and t. IV. i. fig. 6, and Mikrogeo. numer. figs.
Navicula punctulata, Ehren. Mikrogeo. t. XVI. i. fig. 1.

Plate VI. fig. 10.

V. rhomboid-lanceolate, with subacute extremities; striæ

transverse, fine, granular, about 60 in ·001″, shortened opposite the central nodule. Colour of dry valve brown.

The "longitudinal striæ," as they are termed in this species, appear to be produced by plicæ or folds on the surface of the valve.

Hab. Fresh water: frequent in boggy pools in elevated, exposed, or subalpine localities.

Navicula rhomboides, Ehrenberg.

Navicula rhomboides, Ehren. Amer. 1843, t. III. i. fig. 15; Kütz. Bac. p. 94, t. xxviii. fig. 45, and t. xxx. fig. 44; Rabenh. Süssw. Diat. p. 38, t. v. fig. 13, and Europ. Diat. p. 171; Sm. Synop. vol. i. p. 46, pl. xvi. fig. 129, and vol. ii. p. 90; Ralfs, in Prit. Inf. p. 903.

Plate VI. fig. 11.

V. rhomboid-lanceolate, nearly quadrangular, extremities slightly obtuse, or rounded; striæ fine, indistinct, 85 in ·001″, transverse, reaching to the median line.

Hab. Fresh water: frequent, especially in boggy pools in subalpine localities.

Navicula crassinervia, De Brébisson.

Navicula crassinervia, Bréb. in Sm. Synop. vol. i. p. 47, pl. xxxi. fig. 271; Ralfs, in Prit. Inf. p. 900.
Frustulia saxonica, forma aquatica, Rabenh. Europ. Diat. p. 227.

Plate VI. fig. 12.

Frustule small. V. hyaline, lanceolate, gently constricted beneath the obtuse extremities; striæ obscure.

Hab. Fresh water: alpine or subalpine. Snow-mud, Grampians (*Dr. Dickie*); Cheviots, Northumberland, abundant in peat-mosses in exposed situations (*A. S. D.*).

Navicula veneta, Kützing.

Navicula veneta, Kütz. Bac. p. 95, t. xxx. fig. 76; Rabenh. Süssw. Diat. p. 39, t. vi. fig. 83; Ralfs, in Prit. Inf. p. 901.
Navicula gregaria, Donkin, Quart. Micr. Journ. n. s. vol. i. p. 10, pl. i. fig. 10; Rabenh. Europ. Diat. p. 177.
Navicula cryptocephala, var., Rabenh. Europ. Diat. p. 198.

Plate VI. fig. 13.

Frustule minute. V. broadly lanceolate, with slightly produced subacute apices; striæ rather indistinct, fine, connivent, reaching to the median line.

This, though minute, is an exceedingly interesting species, in consequence of having the power of *locomotion* very highly developed. After having been well shook in a bottle and then placed under the microscope, it displays at first great uneasiness and activity; several individuals may be seen directing their course simultaneously, and as it were *voluntarily*, towards any extraneous object near them; to this they soon attach themselves in groups and adhere with wonderful tenacity, remaining at rest when they have once fixed themselves. This highly interesting phenomenon can be readily observed, as this species is very abundant, and may be collected in large quantities.

Hab. Submarine. It is abundant in estuaries and harbours between tide-marks, especially where small streams pass over the sandy beach into the sea. In such situations it is therefore covered with fresh water for a short period during ebb tide and with salt-water for several hours during the flow. It is not, however, confined to the beach, but frequently forms an olive stratum on the surface of piers, stones, and piles in our harbours.

Navicula Crucicula, Smith.

Stauroneis Crucicula, Sm. Synop. vol. i. p. 60, pl. xix. fig. 192; Ralfs, in Prit. Inf. p. 912, pl. vii. fig. 64; Rabenh. Europ. Diat. p. 251.

Plate VI. fig. 14.

V. broadly lanceolate, or elliptical-lanceolate, slightly constricted beneath the obtuse apices; striæ fine, close, slightly oblique, coarse and distant opposite the central nodule.

The appearance of a *stauros*, which this species presents, in the middle of the valve, when viewed with a low power, is deceptive; a careful examination with a high power shows the appearance to be produced by a peculiar modification of the striæ opposite the central nodule, where they are stout, opaque, and distant.

Hab. Brackish water. Belfast Bay, Aug. 1849 (*Prof. Smith*). Estuary of River Blyth, Northumberland (*A. S. D.*).

Subsection VII. *Valve cruciform; striæ fine, transverse, reaching to the median line.*

Navicula Follis, Ehrenberg.

Navicula Follis, Ehren. Inf. 1838, p. 179; Mikrogeo. t. XVI. i. fig. 14, and ii. fig. 12, t. XVII. i. fig. 15, and ii. fig. 21.
Navicula Crux, Ehren. Inf. p. 184.
Navicula inflata, Kütz. Bac. p. 99, t. iii. fig. 36. 1 and 2; Rabenh. Süssw. Diat. p. 41, t. v. fig. 10, and Europ. Diat. p. 191; Ralfs, in Prit. Inf. p. 899.
Frustulia inflata, Kütz. Syn. 1833, t. i. fig. 14.

Plate VI. fig. 15.

Frustule small. V. cruciform, with incurved sides and

slightly turgid, obtuse apices; striæ fine, transverse, distinctly granular, reaching to the median line.

Kützing refers this form to his *N. inflata*; but it is evident that under this name he has included two widely different species, one of which (his typical form) he delineates as unstriated, the other, which he names the variety, being striated; the latter is the *Pinnularia inflata* of Rabenhorst (Süssw. Diat.), and apparently identical with *Navicula inflata* of the 'Synopsis' and of the present work, as will be seen by the synonyms I have given of that species. It follows therefore that the typical *N. inflata* of Kützing must be reduced to a synonym of *N. Follis*. Rabenhorst, more recently (Europ. Diat.), has reunited his *P. inflata* and *N. inflata*, Kütz., with a single description for both, representing the striæ to be from 26 to 30 in ·001″, and distinctly granular. Mr. Ralfs, on the contrary, states that the striæ are absent or indistinct; he, however, like Rabenhorst, refers *N. Follis* to the typical *N. inflata* of Kützing. I consider *N. Follis* to be quite distinct from *N. Trochus*, Ehren.

Hab. Fresh water: rare. Near Heigham, Norfolk (*Mr. Kitton*). I have found it in the Loch-Oich deposit, Caledonian Canal, from which the specimen figured was obtained.

Subsection VIII. *Valve divided into two lobes by a median sinuous constriction; striæ reaching to the median line, but divided into two sections by a longitudinal groove.*

This subsection comprises the genus *Diploneïs* of Ehrenberg. Although an exceedingly natural group, its members are not distinguishable from the *Naviculæ* by any decided generic characters. They are all recognized by two essen-

tial features—*by the median constriction of the valve and by the division of the striæ into an outer conspicuous, and an inner fainter section, by an intersecting longitudinal groove*; this latter character connects them with Division **A** of Subsection I., in which it is also developed, especially in *N. lineata* and *N. suborbicularis*.

Navicula Crabro, Ehrenberg.

Navicula Crabro, Ehren. in Kütz. Spec. Alg. p. 83; Sm. Synop. vol. ii. p. 94; Ralfs, in Prit. Inf. p. 894; Rabenh. Europ. Diat. p. 204.
Navicula pandura, Bréb. Diat. de Cherb. fig. 4; Greg. Trans. Micr. Soc. n. s. vol. iv. p. 43, pl. v. fig. 11; Ralfs, in Prit. Inf. 893.
Navicula nitida, Greg. Trans. Micr. Soc. n. s. vol. iv. p. 44, pl. v. figs. 12 & 12*.
Navicula didyma, costate var., Greg. Trans. Micr. Soc. n. s. vol. iv. p. 45, pl. v. fig. 15.
Pinnularia Crabro, Ehren. Berlin, 1844; Rabenh. Europ. Diat. p. 219.
Pinnularia pandura, Bréb., *var. β. elongata*, Greg. Diat. of the Clyde, p. 17, pl. i. fig. 22.
Diploneïs Crabro, Ehren. Mikrogeo. t. xix. fig. 29.

Plate VII. figs. 1*a* & 1*b*.

Frustule large. V. panduriform, with cuneate, obtuse extremities; striæ subparallel, nearly transverse, costate, or obscurely granular, coarse, about 11 in ·001″, interrupted by a straight longitudinal groove into a broad outer and a narrow inner section, the latter consisting of a longitudinal row of conspicuous hemispherical nodules.

No better illustration than this species could be selected to show the necessity for abolishing the genus *Pinnularia*, and the confusion its establishment has created. It will be seen by the synonyms given that *N. Crabro* has been placed in the genus *Navicula* by some observers and in *Pinnularia* by others, while by others, again, it has been referred to *both* these genera. It is subject to considerable

variation in size and outline; in some specimens an *obscurely granular appearance* of the striæ can be observed, or rather the striæ present the appearance of being tipped with granules, while in others they appear costate. Further, I have in certain portions of the valve, especially in very large specimens from the Red Sea, seen a granular appearance, not observable in other portions. After a most careful examination and comparison of numerous specimens from various localities, including those of *Pinnularia pandura*, Bréb., *var. β. elongata*, of Prof. Gregory, sent to me by him from the Estuary of the Clyde, I feel convinced that the latter form is the typical *N. Crabro* of Ehrenberg.

The form which Dr. Greville has figured as *N. Crabro* (Quart. Micr. Journ. vol. v. p. 7, pl. iii. fig. 11), from the West Indies, is, as I have ascertained from authentic specimens, and as believed by Mr. Ralfs, a different and distinct species, for which I suggest the name of *N. Grevillei*; it is smaller than *N. Crabro*, and distinguished by its *compactly granular striæ, which radiate from the centre of each lobe, and are much more conspicuous near the margin.*

Navicula interrupta, Kützing.

Navicula interrupta, Kütz. Bac. p. 100, t. xxix. fig. 93; Ralfs, in Prit. Inf. p. 894.
Navicula ——, Bailey, in Amer. Journ. of Science, 1842, pl. ii. fig. 18.

Plate VII. fig. 2.

V. divided into two oval or suborbicular lobes by a deep sinuous constriction; striæ costate and radiating from the middle of each lobe, outer section coarse and conspicuous; inner narrow, linear, faint; intersecting groove straight; median line broad.

This species is readily distinguished from *N. Apis*, which

it much resembles in size and outline, by its conspicuous *costate striæ radiating from the middle of each lobe.* Kützing's figure is very characteristic. Rabenhorst by his description appears to have confounded it with *N. Apis.*

Hab. Brackish water. Estuary of River Coquet, Northumberland (*A. S. D.*).

Navicula Apis, Ehrenberg.

Navicula Apis, Ehren. Amer. p. 132, t. III. vii. fig. 18; Kütz. Bac. p. 100, t. xxviii. fig. 76; Rabenh. Süssw. Diat. p. 46, pl. vi. fig. 28; Ralfs, in Prit. Inf. p. 894.
Navicula didyma, var., Sm. Synop. vol. i. p. 53, pl. xvii. fig. 154*a*; Ralfs, in Prit. Inf. pl. vii. fig. 61; Rabenh. Europ. Diat. p. 203.
Navicula interrupta, Kütz.; Rabenh. Europ. Diat. p. 205.

Plate VII. fig. 3.

V. deeply constricted into two oval or suborbicular lobes; striæ nearly transverse, granular, about 26 in ·001″; outer section conspicuous, inner narrow, faint, and linear; median line broad.

The utmost confusion prevails concerning this species, which nevertheless possesses very definite and distinctive characters. The original figures and descriptions of it by Ehrenberg and Kützing represent the striæ to be *parallel and granular,* and the valve to be constricted into two nearly semiorbicular lobes ("media in partes duas fere semiorbiculares constricta, apicibus obtusis, *pinnulis asperis*"). The late Prof. Smith unfortunately described it and *N. interrupta,* Kütz., as synonymous with and constituting an ordinary form of *N. didyma,* Ehren. Rabenhorst (Europ. Diat.) refers *N. Apis* to *N. didyma* as a *variety* with *subparallel striæ,* and evidently confounds it with *N. interrupta,* Kütz., which he erroneously describes as having *granular subradiating* striæ; this description is not appli-

PLATE V.

Fig. 1. Navicula maculosa, Donkin.

2. Navicula lævissima, Kützing.

3. Navicula dirhynchus, Ehrenberg.

4. Navicula Hitchcockii, Ehrenberg.

5. Navicula dubia, Ehrenberg.

6. Navicula Iridis, Ehrenberg.

7. Navicula firma, Kützing.

8. Navicula affinis, Ehrenberg.

9. Navicula amphirhynchus, Ehrenberg.

10. Navicula sphærophora, Kützing.

11*a* & 11*b*. Navicula anglica, Ralfs.

12. Navicula punctata, Kützing.

13. Navicula Amphisbæna, Bory de St. Vincent.

14. Navicula cryptocephala, Kützing.

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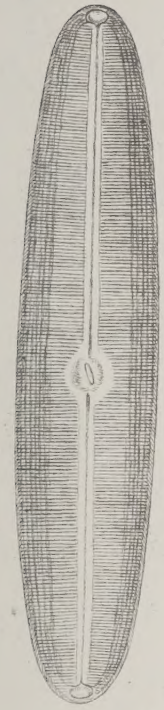
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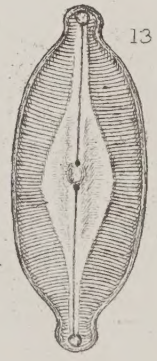
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PLATE VI.

Fig. 1. Navicula undosa, Ehrenberg.

2. Navicula incurva, Gregory.

3. Navicula binodis, Ehrenberg.

4. Navicula rhynchocephala, Kützing.

5. Navicula ambigua, Ehrenberg.

6. Navicula cuspidata, Kützing.

7. Navicula Rostellum, Smith.

8. Navicula integra, Smith.

9. Navicula fulva, Nitzsch.

10. Navicula serians, De Brébisson.

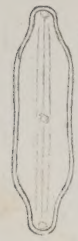
11. Navicula rhomboides, Ehrenberg.

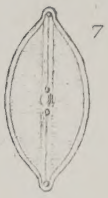
12. Navicula crassinervia, De Brébisson.

13. Navicula veneta, Kützing.

14. Navicula Crucicula, Smith.

15. Navicula Follis, Ehrenberg.





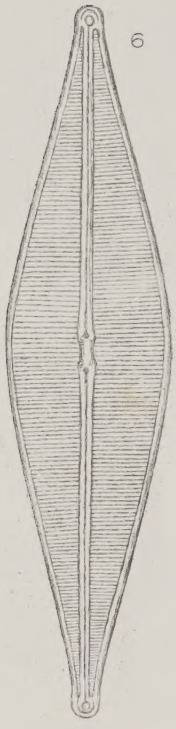


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PLATE VII.

Fig. 1. Navicula Crabro, Ehrenberg. *a*, the typical form, from the coast of Northumberland; *b*, short var., from the estuary of the Clyde.

2. Navicula interrupta, Kützing.

3. Navicula Apis, Ehrenberg.

4. Navicula incurvata, Gregory.

5. Navicula Entomon, Ehrenberg.

6. Navicula Musca, Gregory.

7. Navicula Bombus, Ehrenberg. *a*, the typical form, from the estuary of the Clyde; *b*, the less-constricted var., from the coast of Northumberland.

8*a* & 8*b*. Navicula didyma, Ehrenberg.

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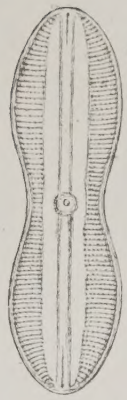
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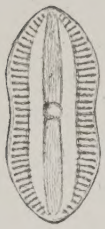
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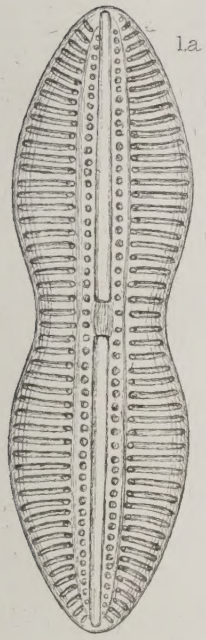
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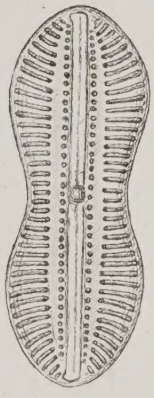
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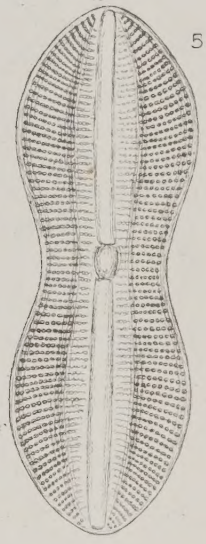
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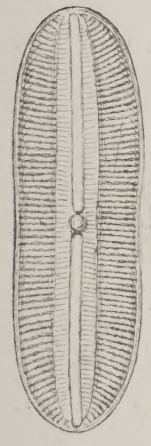
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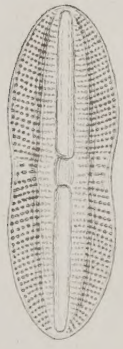
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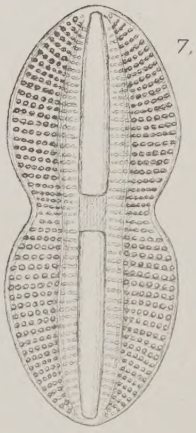
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PLATE VIII.

Fig. 1. Navicula northumbrica, Donkin. *a*, S. V.; *b*, M. V.

2. Navicula inflexa, Gregory. *a*, S. V.; *b*, M. V.

3. Navicula longa, Gregory. *a*, S. V.; *b*, M. V.

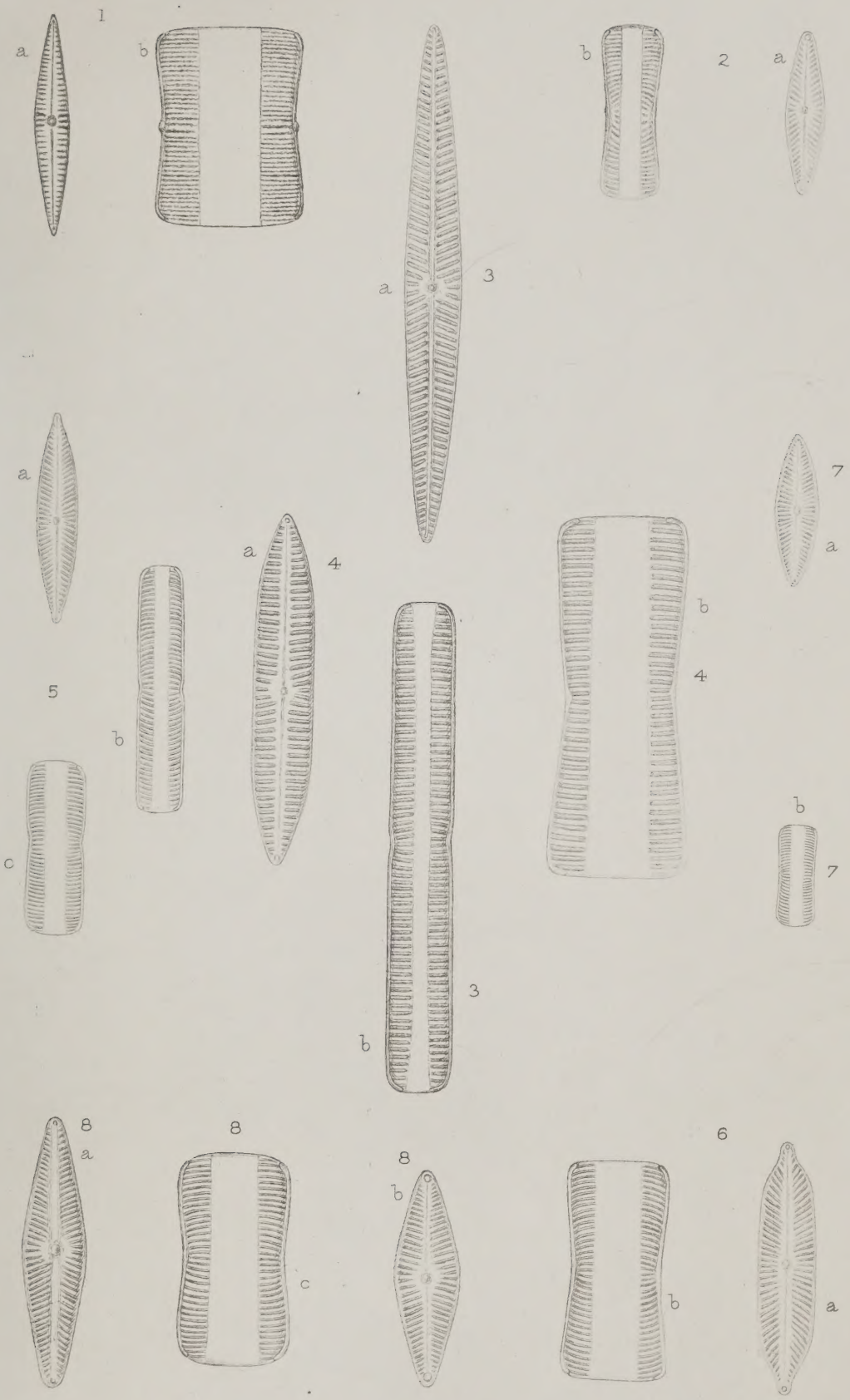
4. Navicula cancellata, Donkin. *a*, S. V.; *b*, M. V.

5. Navicula arenaria, Donkin. *a*, S. V.; *b*, M. V.

6. Navicula apiculata, De Brébisson. *a*, S. V.; *b*, M. V.

7. Navicula minor, Gregory. *a*, S. V.; *b*, M. V.

8. Navicula fortis, Gregory. *a* & *b*, S. V.; *c*, M. V.



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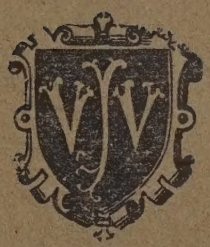

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cable to it, but to *N. Apis*. Kützing's figure of *N. interrupta* represents it as having *costate striæ radiating from the middle of each lobe*, not granular and parallel as in his and Ehrenberg's figures of *N. Apis*.

Hab. Brackish water: frequent. Estuary of River Coquet, Northumberland (*A. S. D.*).

Navicula incurvata, Gregory.

Navicula incurvata, Greg. Trans. Micr. Soc. n. s. vol. iv. p. 44, pl. v. fig. 13; Ralfs, in Prit. Inf. p. 893.
Navicula splendida, Greg., *var.*, Rabenh. Europ. Diat. p. 204.
Navicula interrupta, Kütz., Grunow, in Wien. Verh. 1860, p. 531, t. iii. fig. 20.

Plate VII. fig. 4.

V. somewhat elongate, divided into two elliptical lobes by a gently sinuous constriction; striæ subparallel, fine, granular, about 35 to 40 in ·001″; inner section obscure, linear; median line broad, tapering towards the terminal nodules; central nodule large, orbicular.

Hab. Submarine. Glenshira sand and Estuary of the Clyde (*Prof. Gregory*); Estuary of River Coquet, Northumberland (*A. S. D.*).

Navicula Entomon, Ehrenberg.

Navicula Entomon, Ehren. Leb. Kr. 1840; Kütz. Bac. p. 100, t. xxviii. fig. 74; Ralfs, in Prit. Inf. p. 893.
Pinnularia Entomon, Ehren. Amer. 1844, t. I. i. figs. 3 & 4; Rabenh. Europ. Diat. p. 218.
Diploneïs Entomon, Ehren. Mikrogeo. t. xix. fig. 30.
Navicula splendida, Greg. Trans. Micr. Soc. n. s. vol. iv. p. 44, pl. v. fig. 14; Ralfs, in Prit. Inf. p. 893; Rabenh. Europ. Diat. p. 204.

Plate VII. fig. 5.

Frustule large. V. divided by a gentle sinuous constriction

into two oblong lobes with rounded or subcuneate obtuse extremities; striæ distinctly granular, about 20 in ·001″, transverse in the middle, oblique towards the extremities, outer band conspicuous, inner faint, linear; central nodule large, bulging.

Hab. Salt water. Glenshira sand, Estuary of the Clyde (*Prof. Gregory*). Cresswell, Northumberland (*A. S. D*).

Navicula Musca, Gregory.

Navicula Musca, Greg. Diat. of the Clyde, p. 7, pl. i. fig. 6; Ralfs, in Prit. Inf. p. 893; Rabenh. Europ. Diat. p. 204.
Navicula constricta, Grunow, in Wien. Verh. 1860, p. 535, t. i. fig. 18; Rabenh. Europ. Diat. p. 205.

Plate VII. fig. 6.

Frustule small. V. short, with a sinuous constriction in the middle and cuneate acute, or subacute, extremities; outer section of striæ coarse and obscurely granular, about 18 in ·001″, oblique, inner section obscure; median line broad.

The indistinctness of the inner band of striæ within the longitudinal intersecting groove gives to this species the appearance of having a marginal band of coarse costate-looking striæ.

Hab. Salt water. Estuary of the Clyde and Loch Fine (*Prof. Gregory*).

Navicula Bombus, Ehrenberg.

Navicula Bombus, Ehren., Kütz. Spec. Alg. p. 83; Ralfs, in Prit. Inf. p. 893; Greg. Diat. of the Clyde, p. 12, pl. i. fig. 12; Rabenh. Europ. Diat. p. 204.
Pinnularia Bombus, Ehren. Berlin. 1844.
Diploneïs Bombus, Ehren. Mikrogeo. t. xix. fig. 31.

Navicula didyma, Ehren., Sm. Synop. vol. i. pl. xvii. fig. 154*a*. *Forma typica*, Rabenh. Europ. Diat. p. 203. *New var.* Greg. Trans. Micr. Soc. n. s. vol. iv. p. 45, pl. v. fig. 16.

Plate VII. figs. 7*a* & 7*b*.

V. divided by a sinuous constriction into two broad, somewhat *unequal* lobes, with subcuneate, or rounded, extremities; striæ radiating, coarsely granular, about 20 in ·001″; inner section faint, longitudinal intersecting groove incurved; median line broad, tapering towards the terminal nodules.

This species is very variable in size and outline, and every degree of gradation between the two forms figured is met with.

Hab. Brackish water: common.

Navicula didyma, Ehrenberg.

Navicula didyma, Ehren., Kütz. Bac. p. 100, t. iv. fig. 7, t. xxviii. fig. 75; Ralfs, in Prit. Inf. pl. xv. fig. 12. *var. pinnis manifestis*, Rabenh. Europ. Diat. p. 203.
Pinnularia didyma, Ehren. Amer. II. iv. fig. 3; Rabenh. Süssw. Diat. p. 46, pl. vi. fig. 26.
Diploneïs didyma, Ehren. Mikrogeo. t. xix. fig. 32.

Plate VII. figs. 8*a* & 8*b*.

V. oblong, slightly constricted in the middle, extremities broadly rounded; striæ subparallel, nearly transverse, coarse, obscurely granular, about 17 in ·001″; outer section very conspicuous, inner faint and linear.

The species originally described and figured by Ehrenberg as *Pinnularia didyma* seems to have been lost sight of by recent observers, although his description as given by Kützing is sufficiently plain (*striata, latiuscula, media*

leviter constricta, apice late rotundata); his figure represents it with *parallel striæ*. More recently, in the 'Mikrogeologie,' he has given a more definite figure, which resembles the form selected in the present work to represent *N. didyma* more closely than any other with which I am acquainted. In both of Ehrenberg's figures the striæ are parallel, or transverse, and conspicuous. Prof. Smith, in the 'Synopsis,' figured two widely different species as ordinary forms of *N. didyma*,—one being, as he states, *N. Apis*, Ehren., while the other is evidently the less constricted form of *N. Bombus*, Ehren. Rabenhorst, in 1853 (Süssw. Diat.), appears to have reproduced Ehrenberg's description and figure; in his recent work, however (Europ. Diat.), his description of *N. didyma* is applicable to *N. Bombus*, Ehren., and certainly not to Ehrenberg's type of the former, which he has reduced to a mere variety (*pinnis manifestis*); he has also made *N. Apis*, Ehren., another variety (*pinnis subparallelis*).

These observations will tend to explain the great confusion with which the present species has been surrounded, and the difficulty of ascertaining which is really the original *Pin. didyma* of Ehrenberg.

Hab. Salt or brackish water: frequent. Coast of Northumberland (*A. S. D.*).

Section II. Valve narrow, more or less convex.

It will be observed that the valve, in species typical of Section I. (such as *Navicula elliptica* or *N. prætexta*), is much flattened and broad in proportion to its length, so that the entire frustule is very much broader on its S. V. than on its M. V., which is linear and comparatively narrow. In Section II., however, the relative proportions of the valve and of the frustule are entirely reversed (especially in the more typical forms, such as *N. Northumbrica* and its allies): the former is highly convex and narrow in proportion to its length, while the latter is very much broader on its M. V. than on its S. V. But as these two opposite types of development are receded from in the more aberrant or less typical species, we find the distinctive features of the two sections more and more diminished until they approximate each other very closely. In consequence of this fact an obstacle presents itself to the splitting up of the huge genus *Navicula* into two distinct genera. However the *two primary sections* into which I have divided it may be regarded as equivalent to *subgenera* which gradually approximate to each other, or become almost merged, through the medium of species in which the *sectional* or *subgeneric* characters become less and less distinct.

Subsection I. *Valve highly convex, compressed laterally into a keel elevated towards the extremities and depressed in the middle. Frustule on M. V. broader than on S. V., constricted in the middle and expanded towards the extremities.*

In the peculiar configuration of the valves and of the frustule, the species of this subsection are allied to the genera *Amphiprora* and *Donkinia*, between which and the

Naviculæ they form a connecting link; they constitute a highly natural group, in which the typical characters of Section II. are most highly developed.

A. *Valve lanceolate, linear-lanceolate, or linear; striæ conspicuous, costate, or obscurely granular.*

Navicula Northumbrica, Donkin.

Navicula Northumbrica, Quart. Micr. Journ. n. s. vol. i. p. 9, pl. i. fig. 5; Rabenh. Europ. Diat. p. 175.

Plate VIII. figs. 1*a* & 1*b*.

Frustule on M. V. very broad, quadrangular, slightly constricted in the middle, central nodules prominent, extremities truncate with slightly rounded angles. V. very narrow, lanceolate, acute; striæ transverse, obscurely granular, about 28 in ·001″, those opposite the central nodule coarser, opaque, and slightly convergent.

The lateral compression of the valve in this species is so great that the distance between the two margins is less than that between the margin and the median line; consequently it is difficult to obtain a S. V. of the valve, which generally presents only one of its sides for observation.

Hab. Marine. Cresswell, Tynemouth, and other localities on the sandy beach of Northumberland: abundant. Cumbrae, Clyde; and Teignmouth, S. Devon (*Prof. Walker Arnott*).

Navicula inflexa, Gregory.

Pinnularia inflexa, Greg. Trans. Micr. Soc. n. s. vol. iv. p. 48, pl. v. fig. 20; Rabenh. Europ. Diat. p. 218.
Navicula inflexa, Ralfs, in Prit. Inf. p. 905.

Plate VIII. figs. 2*a* & 2*b*.

Frustule small, on M. V. broad, constricted in the middle,

extremities truncate-rotund. V. lanceolate, subacute, terminal nodules conspicuous; striæ distinct, oblique, connivent, and slightly shortened around the central nodule, reaching to the median line, about 25 in ·001″.

Hab. Marine. Glenshira sand; Estuary of the Clyde (*Prof. Gregory*); Linemouth, coast of Northumberland, abundant (*A. S. D.*).

Navicula longa, Gregory.

Pinnularia longa, Greg. Trans. Micr. Soc. n. s. vol. iv. p. 47, pl. v. fig. 18; Rabenh. Europ. Diat. p. 218.
Navicula longa, Ralfs, in Prit. Inf. p. 906.

Plate VIII. figs. 3*a* & 3*b*.

Frustule much elongated, on M. V. narrow, slightly constricted in the middle, angles rounded. V. narrow, lanceolate, acute; striæ distant, coarse and costate, about 14 in ·001″, oblique, reaching to the median line and shortened opposite the central nodule.

Hab. Marine. Glenshira sand, Lamlash Bay, Isle of Arran, and Estuary of the Clyde (*Prof. Gregory*).

Navicula cancellata, Donkin.

Navicula truncata, Donk. Quart. Micr. Journ. n. s. vol. i. p. 9, pl. i. fig. 4.
Pinnularia truncata, Rabenh. Europ. Diat. p. 217.

Plate VIII. figs. 4*a* & 4*b*.

Frustule on M. V. broad, oblong, rectangular, constricted in the middle, extremities truncate, angles prominent. V. narrow, linear, or linear-lanceolate, extremities tapering, acute or subacute; striæ reaching to the median line, shortened opposite the central nodule, transverse and parallel, coarse and costate, from 14 to 15 in ·001″.

Hab. Marine. Abundant in sand-gatherings, coast of Northumberland (*A. S. D.*). Isle of Arran and Estuary of the Clyde (*Prof. Gregory*).

Navicula arenaria, Donkin.

Navicula arenaria, Donk. Quart. Micr. Journ. n. s. vol. i. p. 10, pl. i. fig. 9; Rabenh. Europ. Diat. p. 177.

Plate VIII. figs. 5*a* & 5*b*.

Frustule on M. V. oblong, slightly constricted in the middle, extremities truncate. V. narrow, lanceolate, slightly constricted near the acute extremities; striæ costate, conspicuous, connivent, reaching to the median line.

Hab. Marine. Abundant in sand-gatherings, coast of Northumberland (*A. S. D.*).

Navicula apiculata, De Brébisson.

Navicula apiculata, Bréb. Diat. de Cherb. p. 16, fig. 5; Ralfs, in Prit. Inf. p. 903.
Pinnularia rostellata, Greg. Diat. of the Clyde, p. 16, pl. i. fig. 20.

Plate VIII. figs. 6*a* & 6*b*.

Frustule on M. V. broad, oblong, constricted in the middle, extremities truncate, angles bevelled. V. linear, constricted into tapering, acute apices; striæ reaching to the median line, very oblique towards the extremities, transverse opposite the central nodule, costate, somewhat distant, about 18 in ·001″.

This species is closely allied to *N. cancellata*, though smaller; its frustule on M. V. is easily recognized from that of the latter by the oblique striæ curving towards the

extremities, instead of appearing as transverse parallel bars.

Hab. Marine. Lamlash Bay, Isle of Arran, and Loch Fine (*Prof. Gregory*); coast of Northumberland, plentiful in sand-gatherings (*A. S. D.*).

Navicula minor, Gregory.

Navicula minor, Greg. Diat. of the Clyde, p. 5, pl. i. fig. 1; Ralfs, in Prit. Inf. p. 909; Rabenh. Europ. Diat. p. 177.

Plate VIII. figs. 7 *a* & 7 *b*.

Frustule small, on M. V. oblong, constricted in the middle, extremities truncate, angles bevelled. V. elliptical, lanceolate, extremities acute, slightly acuminated; striæ oblique, connivent, distinct, 35 in ·001″, somewhat shortened in the middle of the valve.

Hab. Marine. Loch Fine (*Prof. Gregory*). Tynemouth, Northumberland, frequent in sand-gatherings (*A. S. D.*).

Navicula fortis, Gregory.

Pinnularia fortis, Greg. Trans. Micr. Soc. n. s. vol. iv. p. 47, pl. v. fig. 19; Rabenh. Europ. Diat. p. 215.
Navicula fortis, Ralfs, in Prit. Inf. p. 905.

Plate VIII. figs. 8 *a*, 8 *b*, & 8 *c*.

Frustule small, on M. V. broad, short, quadrangular, constricted in the middle, angles slightly rounded, extremities truncate. V. broadly lanceolate or lozenge-shaped, obtuse; striæ reaching to the median line, slightly oblique and connivent, coarse and costate, about 16 in ·001″.

This species is somewhat at variance, in the breadth of

its valve, with the characters assigned to Sec. II.; but in other respects it is quite conformable: its valves are highly convex and keeled, and its frustule on M. V. is broad and constricted, showing its proper position to be in the present subsection.

Hab. Marine. Tynemouth sands Northumberland, South-Shields sands (*A. S. D.*); Clyde (*Prof. Gregory*).

B. *Valve rhomboid or linear; striæ fine, transverse, and parallel, or nearly so, reaching to the median line.*

Navicula rhombica, Gregory.

Navicula rhombica, Greg. Quart. Micr. Journ. vol. iii. p. 40, pl. iv. fig. 16, and Trans. Micr. Soc. n. s. vol. iv. p. 38, pl. v. fig. 1; Ralfs, in Prit. Inf. p. 903, pl. vii. fig. 71; Rabenh. Europ. Diat. p. 181.

Navicula Libellus, Greg. Diat. of the Clyde, p. 57, pl. vi. fig. 101; Ralfs, in Prit. Inf. p. 904; Rabenh. Europ. Diat. p. 172.

Plate IX. figs. 1 *a* & 1 *b*.

Frustule on M. V. broad, quadrate, slightly constricted in the middle, angles slightly rounded, extremities truncate; connecting zone traversed by longitudinal lines. V. hyaline, rhombic, or elliptical-lanceolate, with subacute or obtuse extremities; striæ fine, about 45 in ·001″, reaching to the median line, nearly transverse, but slightly connivent and more opaque and distinct around the central nodule.

Hab. Salt water. Glenshira sand and Tantallon, Haddingtonshire; Estuary of the Clyde (*Prof. Gregory*); Newbiggin, Northumberland (*A. S. D.*).

Navicula plicata, Donkin, n. sp.

Plate IX. figs. 2 *a* & 2 *b*.

Frustule on M. V. broad, oblong, slightly constricted in the middle, extremities truncate, angles slightly rounded, connecting zone traversed by longitudinal lines. V. narrow, linear, extremities tapering, obtuse; striæ fine, transverse, reaching to the median line, distinct, above 50 in ·001″.

I discovered this species in great abundance in a living state, in June and July 1869, associated with *N. forcipata*, *N. abrupta*, *N. humerosa*, and other marine species, in sand-gatherings, in a secluded nook on the sea-shore near Warkworth, Northumberland. It is closely allied to *N. rhombica*, Greg., and to *N. Auklandica*, Grunow (Wien. Verh. 1863, p. 151, t. xiv. fig 14); it differs from *N. rhombica* in its longer, much narrower, almost linear valve and tapering obtuse extremities, and in its striæ, which are transverse and of uniform distinctness throughout. It resembles *N. Auklandica* in size and outline, but differ in having much finer striæ and the connecting zone destitute of longitudinal rows of nodules. Grunow describes *N. Auklandica* as having subparallel striæ, coarser in the middle of the valve and 36 in ·001″, the connecting zone as exhibiting longitudinal lines of transversely elongated nodules: he states that it was collected on the sandy beach of the Aukland Islands by De Frauenfeld (Exped. Novara); it will be observed, therefore, that the habitat of this species is exactly that of *N. plicata*. Prof. Gregory doubted whether *N. rhombica* and his *N. Libellus* are *Naviculæ*, thinking that possibly they might be found to belong to the genus *Schizonema*: the discovery, however, on the open beach of *N. plicata* by myself in great abundance in a

free condition, and of *N. Auklandica* by De Frauenfeld in similar localities, certainly negatives this supposition.

Hab. Marine. Warkworth, Northumberland, abundant in sand-gatherings, June and July 1869 (*A. S. D.*).

Navicula simulans, Donkin.

Amphiprora constricta, Ehren. Amer. 1844, p. 122, t. II. vi. fig. 28; Kütz. Bac. p. 107, t. xxix. fig. 34; Sm. Synop. vol. i. p. 44, pl. xv. fig. 126; Ralfs, in Prit. Inf. p. 922, pl. xii. fig. 1; Rabenh. Europ. Diat. p. 253.

Plate IX. figs. 3 *a* & 3 *b*.

Frustule on M.V. oblong, with a sinuous constriction in the middle, extremities truncate, angles gently rounded. V. hyaline, linear, with cuneate subacute extremities; striæ very fine, obscure (68 in ·001″, Smith), transverse, reaching to the median line, much shortened opposite the central nodule, so as to leave a transverse median blank space reaching near to the margin.

Although this species has hitherto been described as an *Amphiprora*, it is wanting in the distinctive characters of this latter genus, between which and the *Naviculæ* it forms one of the connecting links. It is undoubtedly a *Navicula*, and its proper position in the present subsection, being allied to *N. maxima*, Greg.

Hab. Salt water: frequent. Coast of Sussex (*Prof. Smith*); Newbiggin, Northumberland (*A. S. D.*); near Hull, common (*Mr. Norman*).

Navicula maxima, Gregory.

Navicula maxima, Greg. Quart. Micr. Journ. vol. iii. p. 41, pl. iv. fig. 19, and Trans. Micr. Soc. n. s. vol. iv. p. 39, pl. v. figs. 2, 2**.

Navicula excentrica, Grun. in Wien. Verh. 1860, p. 545, t. i. fig. 1.
Navicula bicuneata, Grun. in Wien. Verh. 1860, p. 546, t. i. fig. 4; Rabenh. Europ. Diat. p. 206.
Navicula Liber, Smith, *var. b. forma major*, Rabenh. Europ. Diat. p. 180.

Plate IX. fig. 4.

Frustule large, on M. V. oblong, constricted in the middle, angles rounded, ends truncate. V. linear, or sublinear with a gentle sinuous constriction in the middle, extremities cuneate, obtuse; striæ transverse, reaching to the median line, fine, about 45 in ·001″, crossed by one or two longitudinal lines extending between the apices.

Much confusion prevails concerning this species, which was first discovered by Prof. Gregory in the Glenshira sand, and described in his papers on this deposit (*loc. cit.*); unfortunately, he subsequently described and figured *N. Liber*, Sm., as the typical *N. maxima*, and reduced the original form which he had so named to a *variety*. Grunow in 1860 (*op. cit.*) made two new species of Gregory's original *N. maxima*; these he named *N. excentrica* and *N. bicuneata*; but afterwards, in 1863, he reduced them to synonyms of *N. Liber*, the striæ of which he estimates at from 40 to 52 in ·001″—a range of variation, however, which certainly does not prevail in any known species. Rabenhorst (*op. cit.*) retained Grunow's *N. bicuneata*, but referred his *N. excentrica* to *N. Liber*, as a large variety (*forma major*), notwithstanding the authority of the latter that both are identical. The specimen figured in the present work is from the estuary of the Clyde, and supplied to me by the late Prof. Gregory.

Hab. Marine. Glenshira sand, Lamlash Bay, Isle of Arran, and Estuary of the Clyde (*Prof. Gregory*). This species also occurs in the Mediterranean and Adriatic.

Navicula Liber, Smith.

Navicula Liber, Sm. Synop. vol. i. p. 48, pl. xvi. fig. 133; Ralfs, in Prit. Inf. p. 907; Rabenh. Europ. Diat. p. 180.
Navicula maxima, Greg. Diat. of the Clyde, p. 15, pl. i. fig. 18; Rabenh. Europ. Diat. p. 172; Ralfs, in Prit. Inf. p. 909, pl. vii. fig. 75.
Navicula linearis, Grun. in Wien. Verh. 1860, p. 546, t. i. fig. 2; Rabenh. Europ. Diat. p. 180.

Plate IX. figs. 5 *a* & 5 *b*.

Frustule much elongated, on M. V. rectangular, slightly constricted in the middle, angles bevelled. V. linear, with rounded extremities; striæ reaching to the median line, transverse, very fine, above 50 in ·001″; dry valve straw-coloured.

Distinguished from *N. maxima* by its smaller size, narrower valve, rounded extremities, curved median line, and finer striæ, and by the much more prominent angles and less deeply constricted sides of the frustule on M. V.

Hab. Marine: frequent. Coast of Sussex (*Prof. Smith*); Loch Fine (*Prof. Gregory*); coast of Northumberland, frequent in sand-gatherings (*A. S. D.*).

C. *V. linear-lanceolate; striæ oblique, distinct, and granular.*

Navicula aspera, Ehrenberg.

Stauroptera aspera, Ehren. Amer. p. 134, t. I. i. fig. 12, iii. figs. 1 & 2, II. vi. fig. 20, III. vii. fig. 26, and IV. iv. fig. 1, Mikrogeo. t. xix. fig. 26; Rabenh. Süssw. Diat. p. 49, t. ix. fig. 1.
Frustulia fulva, Bréb. in Herb. Binder.
Stauroneis aspera, Kütz. Bac. p. 106, t. xxix. fig. 12; Ralfs, in Prit. Inf. p. 914; Rabenh. Europ. Diat. p. 250.
Stauroptera Achnanthes, Ehren. Amer. p. 135, t. III. iii. fig. 7, and VI. iii. fig. 2, Mikrogeo. pl. XVII. i. fig. 10; Rabenh. Süssw. Diat. p. 49, t. ix. fig. 2.
Stauroneis Achnanthes, Kütz. Bac. p. 106, t. xxix. figs. 20 & 22; Ralfs, in Prit. Inf. p. 913; Rabenh. Europ. Diat. p. 248.
Stauroneis pulchella, Sm. Synop. vol. i. p. 61, pl. xix. fig. 194; Ralfs, in

Prit. Inf. p. 914, pl. vii. fig. 77; Rabenh. Europ. Diat. p. 251; Heib. Cons. p. 84. n. 6.

Plate X. figs. 1*a*, 1*b*, & 1 *c*.

Frustule large, elongated, on M. V. oblong, constricted in the middle, angles much rounded, extremities truncate. V. linear-lanceolate or elliptical-lanceolate, with obtuse or subacute extremities; striæ oblique, distinct, and granular, 20 in ·001″, reaching to the median line, much shortened (so as to form a narrow, linear, marginal band, and to leave a cuneiform blank space) opposite the central nodule. Dry valve tawny-coloured.

This species, originally placed by Ehrenberg in his genus *Stauroptera*, and afterwards by Kützing and subsequent observers in the genus *Stauroneis*, is a genuine *Navicula*, and so closely allied to *N. Clepsydra*, Donk., that to place these two species in different genera would be a violation of correct classification; the proper position for both forms is in the present subsection. Prof. Walker Arnott (Quart. Micr. Journ. vol. vii. p. 176) correctly pointed out that the striation in both species is different from what is usually observed in the genus *Stauroneis*. *N. aspera* is very variable in size, the small variety figured being evidently the *Stauroptera Achnanthes* of Ehrenberg.

Hab. Marine: frequent in rocky pools, and generally distributed.

Navicula Clepsydra, Donkin.

Navicula Clepsydra, Donk. Quart. Micr. Journ. n. s. vol. i. p. 8, pl. i. fig. 3; Rabenh. Europ. Diat. p. 181.

Plate X. figs. 2 *a* & 2 *b*.

Frustule large, elongated, on M. V. broad, quadrangular,

constricted in the middle, angles prominent, extremities truncate. V. linear-lanceolate or linear-elliptical, with rounded extremities; striæ oblique, granular, distinct, 25 in ·001″, reaching to the median line, much shortened (so as to leave an imperfectly orbicular blank space) around the central nodule; colour of dry valve bluish green.

This species differs from *N. aspera* in the colour, outline, and *much greater convexity* of the valve, in the finer striæ and the *orbicular* shape of the blank space around the central nodule, in the angles of the frustule on M. V. being *prominent* and sharp, and the middle *more deeply constricted*; it differs also in its *habitat*, which is the sandy beach.

Hab. Marine: in sand-gatherings frequent, and occasionally quite pure and abundant. Cresswell, Boulmar, Newbiggin, and Tynemouth sands, Northumberland, South-Shields sands, Durham (*A. S. D.*).

D. *Valve linear, with rounded extremities; striæ coarse and costate.*

* *Not inflated in the middle.*

Navicula retusa, De Brébisson.

Navicula retusa, Bréb. Diat. de Cherb. p. 16, fig. 6; Sm. Synop. vol. ii. p. 92; Ralfs, in Prit. Inf. p. 908; Donk. in Quart. Micr. Journ. n. s. vol. i. p. 14, pl. i. fig. 17; Rabenh. Europ. Diat. p. 186.
Navicula pectinalis, Bréb. Sm. Synop. vol. ii. p. 91; Ralfs, in Prit. Inf. p. 909; Rabenh. Europ. Diat. p. 186.

Plate X. figs. 3 *a* & 3 *b*.

Frustule small, on M. V. oblong, constricted in the middle, angles rounded, extremities truncate. V. narrow, linear, with rounded extremities; striæ not reaching to the median line, nearly transverse, distant, coarse, and costate, 20 in ·001″.

I have been induced to reduce *N. pectinalis*, Bréb., of Smith's Synop. to a synonym of *N. retusa*, Bréb., because the valve of the latter corresponds with Smith's description of that of the former, which does not accord with any other allied species, and because of the following observation of Prof. Walker Arnott on the subject:—"It is not to me quite clear on what De Brébisson originally bestowed the name of *N. pectinalis*; what Smith received from him and supposed to be so, I have reason to think was *N. retusa*, of which Smith only knew the F. V.; and in that state it is almost undistinguishable from *N. pectinalis* of the Synopsis" (Quart. Micr. Journ. vol. vii. p. 176).

Hab. Marine: frequent in sand-gatherings near estuaries.

† *More or less inflated in the middle.*

Navicula cruciformis, Donkin.

Navicula cruciformis, Donk. Quart. Micr. Journ. n. s. vol. i. p. 10, pl. i. fig. 7.
Pinnularia Brébissonii, var. d, Rabenh. Europ. Diat. p. 222.

Plate X. fig. 4.

Frustule on M. V. broad, oblong, quadrangular, constricted in the middle, angles bevelled. V. linear, slightly inflated in the middle, extremities rounded; striæ reaching to the median line, very oblique, and diverging midway between the central and terminal nodules, costate, 30 in ·001″, absent (so as to leave a broad cuneiform blank space) opposite the central nodule; dry valve brown-coloured.

Rabenhorst has referred this species to *N. Brébissonii* as a variety, forgetting that I described it as being a marine

form; moreover it differs essentially in the structure of the valve and in the contour of the frustule on M. V. from *N. Brébissonii*, which in this aspect is linear, not constricted, and narrower.

Hab. Marine. Coast of Northumberland, common in sand-gatherings (*A. S. D.*).

Navicula rectangulata, Gregory.

Navicula rectangulata, Greg. Diat. of the Clyde, p. 7, pl. i. fig. 7; Ralfs, in Prit. Inf. p. 907.
Pinnularia rectangulata, Rabenh. Europ. Diat. p. 215.

Plate X. fig. 5.

Frustule on M. V. oblong, constricted in the middle, extremities truncate, angles bevelled. V. linear, bulging in the middle and near the broadly rounded extremities; striæ reaching to the median line, slightly shortened around the central nodule, oblique, diverging midway between the central and terminal nodules, distinct, costate, 20 in ·001″.

Hab. Marine. Lamlash Bay, Isle of Arran (*Prof. Gregory*); coast of Northumberland, common in sand-gatherings (*A. S. D.*); New Brighton sands and Leasowe sands, near Liverpool (*Mr. Comber*).

Navicula Trevelyana, Donkin.

Navicula Trevelyana, Donk. Quart. Micr. Journ. n. s. vol. i. p. 8, pl. i. fig. 2.
Pinnularia Trevelyana, Rabenh. Europ. Diat. p. 210.

Plate X. figs. 6 *a* & 6 *b*.

Frustule elongated, on M. V. broad, oblong, deeply constricted in the middle, extremities truncate, angles

rounded. V. linear, slightly dilated at the middle and near the rounded extremities; striæ coarse, costate, very oblique, diverging midway between the central and terminal nodules, reaching to the median line, much shortened around the central nodule, so as to leave a large orbicular median blank space, 25 in ·001″.

This large and beautiful species is readily distinguished from *N. rectangulata*, Greg., by its larger size, more oblique striæ, and large orbicular blank space around the central nodule, and more especially by the peculiarly curved appearance imparted to the median line by the great convexity of the valve near the extremities, and its depression in the middle; it was discovered by me at Cresswell, Northumberland, in June 1857, and dedicated to my friend Sir W. C. Trevelyan, Bart., of Nettlecombe, Somersetshire, and of Wallington, Northumberland.

Hab. Marine. Cresswell, Linemouth, and Boulmar, Northumberland, frequent in sand-gatherings (*A. S. D.*).

Navicula humilis, Donkin, n. sp.

Navicula varians, var., Greg. Trans. Micr. Soc. n. s. vol. iii. pl. ii. figs. 20 & 20*b*.
Navicula inflata, var., Greg. Trans. Micr. Soc. n. s. vol. iii. pl. ii. fig. 20*c*.

Plate X. figs. 7*a* & 7*b*.

Frustule minute, on M.V. broad, quadrate, constricted in the middle, extremities rotund-truncate, angles prominent, central nodules projecting. V. linear, much inflated in the middle, extremities broadly rounded and tumid; striæ reaching to the median line, convergent, coarse, costate, and very conspicuous.

This is the only freshwater species with which I am

acquainted belonging to the present subsection. Prof. Gregory has given three figures of the S. V., which he regarded as *var.* of *N. inflata* and of his *N. varians*; he appears, however, to have been unacquainted with the highly convex and keeled characters of the valve, and with the contour of the frustule on M. V., features which undoubtedly establish its position in this subsection.

Hab. Fresh water. River Coquet and Sweethope Lough, Northumberland (*A. S. D.*); Scotland (*Prof. Gregory*).

Subsection II. *Valve moderately convex, not compressed laterally into a keel; frustule on M. V. linear, not constricted in the middle, and of equal or nearly equal breadth with the S. V.*

A. *Valve linear, dilated in the middle.*

* *Striæ oblique, connivent.*

Navicula nobilis, Ehrenberg.

Pinnularia nobilis, Ehren. Berl. 1840, p. 20; Rabenh. Süssw. Diat. p. 44, t. vi. fig. 2, Europ. Diat. p. 209; Sm. Synop. vol. i. p. 54, pl. xvii. fig. 161.
Navicula nobilis, Kütz. Bac. p. 98, t. iv. fig. 24; Ralfs, in Prit. Inf. p. 895.
Pinnularia mesogongyla, Ehren. Mikrogeo. t. VI. i. fig. 5.

Plate XI. fig. 1.

Frustule very large, elongated. V. broad, linear, slightly bulging in the middle and at the extremities; striæ not reaching to the median line, stout, costate, obliquely inclined towards the central nodule, 13 in ·001″.

Hab. Fresh water: common in boggy pools and ditches in hilly and upland districts. Lough-Mourne deposit, Dolgelly earth, &c.

Navicula gentilis, Donkin, n. sp.

Navicula major, var. b. crassa, Bréb. in Rabenh. Alg. n. 683; Europ. Diat. p. 210?

Plate XII. fig. 1.

Frustule large, elongated. V. linear, slightly bulging in the middle and expanding towards the broadly rounded clavate extremities; striæ not reaching to the median line, strongly costate and obliquely inclined towards the central and terminal nodules, 18 in ·001″.

This species is quite distinct from *N. nobilis,* which it resembles, being very much smaller, proportionally broader at the extremities, and having much finer striæ. Nevertheless it appears to have been confounded with the latter species and with *N. major.*

Hab. Fresh water: frequent. In hilly districts: Cheviots, Northumberland; Lough-Mourne deposit, &c.

Navicula major, Kützing.

Navicula major, Kütz. Bac. p. 97, t. iv. figs. 19 & 20; Ralfs, in Prit. Inf. p. 896, pl. vii. fig. 65.
Bacillaria fulva, Nitzsch (ex parte), t. ii. figs. 13 & 17, 1817.
Frustulia major, Kütz. Syn. p. 19, fig. 25, 1833.
Navicula viridis, Ehren. in Pogg. Ann. 1836, t. iii. fig. 1, Inf. 1838, t. xiii. fig. 16, t. xxi. fig. 12; Baily, in Amer. Journ. Jan. 1832, pl. ii. figs. 16 & 17.
Pinnularia viridis, Ehren. Amer. 1843, t. I. i. fig. 7, iii. fig. 3, iv. fig. 3, t. II. i. fig. 22, iii. fig. 1, v. fig. 2, vi. fig. 21, t. III. i. figs. 1 & 2.
Pinnularia major, Rabenh. Süssw. Diat. p. 42, t. vi. fig. 5, Alg. n. 621 & 1485, and Europ. Diat. p. 210; Sm. Synop. vol. i. p. 54, pl. xviii. fig. 162.

Plate XI. figs. 2*a* & 2*b*.

Frustule large, elongated. V. broadly linear, turgid in the middle; extremities gently and gradually rounded; striæ not reaching to the median line, strongly

costate, convergent around the central nodule, 18 in ·001″.

Hab. Fresh water : common in lakes, ponds, and ditches. Loch-Oich deposit, abundant. This species is much more lacustrine in its habitat than the two preceding species.

Navicula Tabellaria, Ehrenberg.

Pinnularia Tabellaria, Ehren. Amer. t. II. i. fig. 26, III. i. fig. 7, iii. fig. 6, iv. fig. 5, IV. i. fig. 4.
Pinnularia acrosphæria, Rabenh. Süssw. Diat. p. 45, t. vi. fig. 36.
Pinnularia leptogongyla, Ehren. Mikrogeo. figg. permult; Rabenh. Europ. Diat. p. 188.
Navicula leptogongyla, Ehren. Amer. 1843, p. 130.
Navicula acrosphæria, Kütz. Bac. p. 97, t. 5. fig. 2; Ralfs, in Prit. Inf. p. 896.

Plate XII. fig. 4.

Frustule smallish, elongated. V. rather narrow, linear, slightly bulging in the middle and gently rounded at the extremities; striæ reaching near to the median line, obliquely inclined and gradually shortened around the central nodule, 22 in ·001″.

This is the *Pinnularia Tabellaria* of Ehrenb. and the *Navicula acrosphæria* of Kützing, concerning both of which species the greatest confusion has prevailed. (See Note to *Nav. acrosphæria*).

Hab. Fresh water, frequent in hilly and mountainous districts. Cheviots, Northumberland (*A. S. D.*); Scottish Highlands. Loch-Oich deposit, Lough-Mourne deposit, &c.

Navicula gibba, Ehrenberg.

Stauroptera gibba, Ehren. Amer. p. 135, t. I. ii. fig. 3; Rabenh. Süssw. Diat. p. 49, t. ix. fig. 3.
Stauroneis gibba, Kütz. Bac. p. 107, t. xxix. fig. 24; Ralfs, in Prit. Inf. p. 914.

Pinnularia gibba, Sm. Synop. vol. i. p. 58, pl. xix. fig. 180?
Pinnularia Tabellaria, Sm. Synop. vol. i. p. 58, pl. xix. fig. 181?

Plate XII. fig. 3.

Frustule of median size, elongated. V. narrowish, linear, bulging in the middle and at the rounded extremities: striæ not reaching to the median line, much shortened and often interrupted on one side of the central nodule, very oblique, subdistant, stout and costate, 23 in ·001″.

Hab. Fresh water, frequent in boggy pools in elevated and hilly districts. Loch-Oich deposit, Lough-Mourne deposit, Premnay Peat, &c.

Navicula lata, De Brébisson.

Navicula lata, Bréb. Considér. sur les Diatom. 1838, p. 18; Kütz. Sp. Alg. p. 79; Ralfs, in Prit. Inf. p. 908.
Pinnularia lata, Sm. Synop. vol. i. p. 55, pl. xviii. fig. 167; Rabenh. Europ. Diat. p. 212, and Süssw. Diat. p. 42.
Pinnularia pachyptera, Ehren. Amer. 1844, p. 133, t. IV. ii. fig. 9; Rabenh. Süssw. Diat. p. 45, t. vi. fig. 11.
Navicula pachyptera, Kütz. Bac. p. 98, t. xxviii. fig. 58; Ralfs, in Prit. Inf. p. 896.
Pinnularia megaloptera, Ehren. Mikrogeo. t. III. i. fig. 4; Greg. Quart. Micr. Journ. vol. iv. p. 3, pl. i. fig. 6.
Navicula Suecica, Ehren. Inf. 1838, p. 189, t. xxi. fig. 18; Kütz. Bac. p. 96, t. xxi. fig. 16; Ralfs, in Prit. Inf. p. 908.
Pinnularia Suecica, Ehren. Mikrogeo.; Rabenh. Süssw. Diat. p. 42, t. vi. fig. 14.

Plate XIII. figs. 1*a* & 1*b*.

Frustule short, oblong. V. broad linear, slightly dilated in the middle, and broadly rounded at the extremities (in short specimens elliptical or linear-elliptical); striæ not reaching to the median line, much shortened and connivent around the central nodule, distant, broad and costate, 8 in ·001″.

This species is very variable in size and outline, the

short elliptical form being the *Pinnularia Suecica* of Ehrenberg.

Hab. Fresh water. Frequent in hilly and subalpine localities in England, Scotland, and Ireland.

† *Striæ parallel, transverse.*

Navicula acrosphæria, De Brébisson.

Frustulia acrosphæria, Bréb. Considér. sur les Diatom. p. 19, 1838.
Navicula Tabellaria, Kütz. Bac. p. 98, t. xxviii. figs. 79 & 80, t. xxx. fig. 20; Ralfs, in Prit. Inf. p. 896, pl. xii. fig. 21.
Pinnularia Tabellaria, Ehren.; Rabenh. Süssw. Diat. p. 44, t. vi. fig. 24, and Europ. Diat. p. 211; *var. acrosphæria*, Rabenh. Europ. Diat. p. 211.
Pinnularia acrosphæria, Sm. Synop. vol. i. p. 58, pl. xix. fig. 183.
Navicula punctata, Bréb. Journ. of Quekett Micr. Club, Apr. 1870.
Pinnularia gibba, Rabenh. Süssw. Diat. t. vi. fig. 27 *a*.
Pinnularia gibberula, Rabenh. Süssw. Diat. p. 45, t. vi. fig. 30.

Plate XII. fig. 2.

Frustule smallish, oblong. V. broadly linear, dilated in the middle and at the broadly rounded extremities; striæ short, not reaching to the median line, distinct, costate, subdistant, parallel and transverse, 26 in ·001″; surface of the valve irregularly granular.

The short transverse striæ and the mottled appearance of the valve at once distinguish this species from its congeners. In describing it under the name of *N. punctata*, at the suggestion of the late Prof. Walker Arnott, De Brébisson observes (*op. cit. supra*) :—"It is this species to which I had in 1838 given the name of *Frustulia acrosphæria*; but it is not the *Navicula acrosphæria* of Kützing, *the summits of which are not sensibly enlarged*—nor, as some authors have thought, the *Navicula Tabellaria* of Ehrenberg, which has no punctuations." To avoid confusion, I have adopted the original specific name of De Brébisson.

Navicula scopulorum, De Brébisson.

Navicula scopulorum, Bréb. in Kütz. Spec. Alg. p. 81; Ralfs, in Prit. Inf. p. 895; Rabenh. Süssw. Diat. p. 41, t. v. fig. 7.
Navicula mesotyla, Ehren. Amer. 1843, p. 130; Kütz. Bac. p. 99, t. v. fig. 3, and t. xxviii. fig. 84; Rabenh. Süssw. Diat. p. 41, t. v. fig. 6?
Pinnularia Johnsonii, Sm. Synop. vol. i. p. 58, pl. xix. fig. 179; Rabenh. Europ. Diat. p. 211.

Plate XII. fig. 5.

Frustule much elongated, slender. V. narrow, linear, inflated in the middle and at the rounded extremities; striæ reaching to the median line, parallel, transverse, faint, 56 in ·001″; colour of dry valve brownish.

Hab. Brackish water. Pilling near Lancaster (*Mr. Johnson*, Feb. 1851). Shoreham, Sussex, March, 1851 (*Prof. Smith*). Piers, Victoria Dock, Hull, and Lagoon, Grimsby (*Mr. Norman*); Bootle shore near Liverpool (*Mr. Comber*).

Navicula limosa, Kützing.

Navicula limosa, Kütz. Bac. p. 101, t. iii. fig. 50; Rabenh. Süssw. Diat. p. 41, t. vi. fig. 31, and Europ. Diat. p. 188; Ralfs, in Prit. Inf. p. 894; *var. inflata*, Grunow, in Wien. Verh. 1860, p. 544, t. iii. fig. 8 *c.*; and *var. bicuneata*, Grunow, in Wien. Verh. 1860, p. 544, t. iii. fig. 7.
Navicula gibberula, Kütz. Bac. p. 101, t. iii. fig. 50*; Sm. Synop. vol. i. p. 51, pl. xvii. fig. 160; Ralfs, in Prit. Inf. p. 895.
Navicula leptogongyla, Ehren.; Kütz. Bac. p. 99, t. iv. fig. 9; Rabenh. Süssw. Diat. p. 41, t. v. fig. 8.
Navicula tumidula, Rabenh. Süssw. Diat. p. 41, t. v. fig. 9, and Europ. Diat. p. 188; Ralfs, in Prit. Inf. p. 895.
Navicula Silicula, Ehren. Amer. p. 131. n. 161, Mikrogeo. fig. numer.; Kütz. Bac. p. 101; Ralfs, in Prit. Inf. p. 894; Rabenh. Süssw. Diat. p. 41, and Europ. Diat. p. 206.

Plate XII. figs. 6*a* & 6*b*.

Frustule small, oblong. V. highly convex, narrow, linear,

with a central and terminal inflations, extremities cuneate and subacute, or rounded; striæ reaching to the median line, transverse, fine and delicate; dry valve yellowish brown.

The great variation in size and outline to which this species is subject has caused it to be described under the various synonyms given above. Kützing seems to have relied on size and outline in separating *N. gibberula* as a species distinct from *N. limosa*.

Hab. Fresh water: common and very generally distributed.

Navicula ventricosa, Ehrenberg.

Navicula ventricosa, Ehren. Kreidethierchen, 1839, t. iv. fig. 10; Kütz. Bac. p. 99, t. xxi. fig. 15.

Plate XII. fig. 7.

Frustule small, oblong. V. highly convex, linear, inflated in the middle; extremities slightly tumid and rounded; striæ reaching to the median line, transverse, fine and delicate, absent opposite the central nodule.

This species is distinguished from the preceding, with which it has evidently been confounded, by its smaller size and the blank unstriated space opposite the central nodule. It agrees with the figure of *N. ventricosa*, Ehren. given by Kützing, to which I have referred it, to prevent the introduction of a new name.

Hab. Fresh water: frequent in elevated situations. Sweethope Lough, Northumberland; Loch-Oich deposit.

PLATE IX.

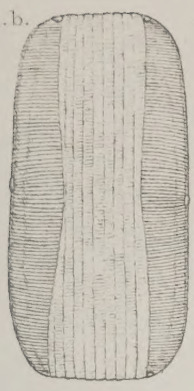
Fig. 1. Navicula rhombica, Gregory. *a*, S. V.; *b*, M. V.

2. Navicula plicata, Donkin. *a*, S. V.; *b*, M. V.

3. Navicula simulans, Donkin. *a*, S. V.; *b*, M. V.

4. Navicula maxima, Gregory. S. V., from an original specimen from the Clyde, sent to the author by Prof. Gregory.

5. Navicula Liber, Smith. *a*, S. V.; *b*, M. V.



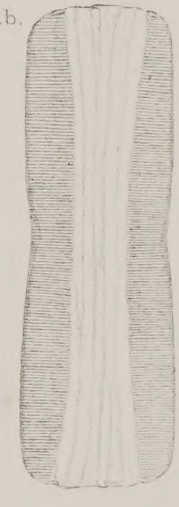


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PLATE X.

Fig. 1. NAVICULA ASPERA, Ehrenberg. *a*, S. V., typical; *b*, short var.; *c*, M. V.

2. NAVICULA CLEPSYDRA, Donkin. *a*, S. V.; *b*, M. V.

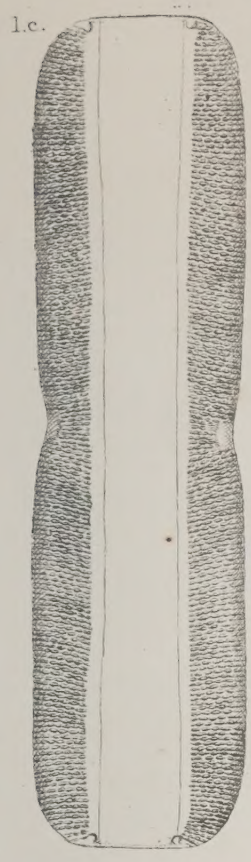
3. NAVICULA RETUSA, De Brébisson. *a*, S. V.; *b*, M. V.

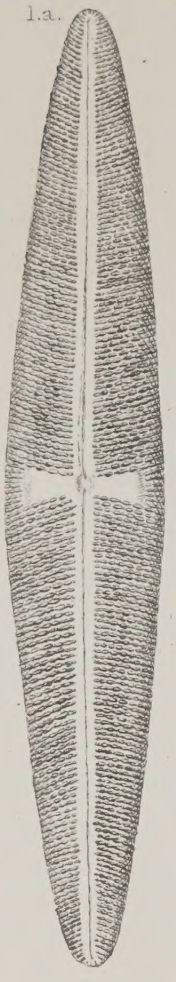
4. NAVICULA CRUCIFORMIS, Donkin. S. V.

5. NAVICULA RECTANGULATA, Gregory. S. V.; the M. V. of this species and of *N. cruciformis* closely resembles that of *N. Trevelyana*.

6. NAVICULA TREVELYANA, Donkin. *a*, S. V.; *b*, M. V.

7. NAVICULA HUMILIS, Donkin. *a*, S. V.; *b*, M. V.


1.c.


1.a.

2.a.

2.b.

1.b.

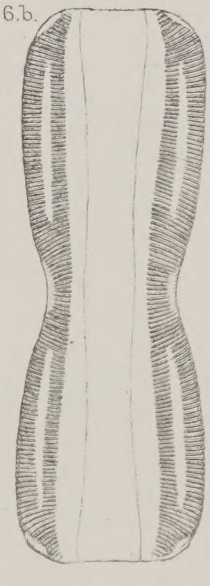
3.b.

3.a.

7.a.

7.b.

6.a.


6.b.

4

5

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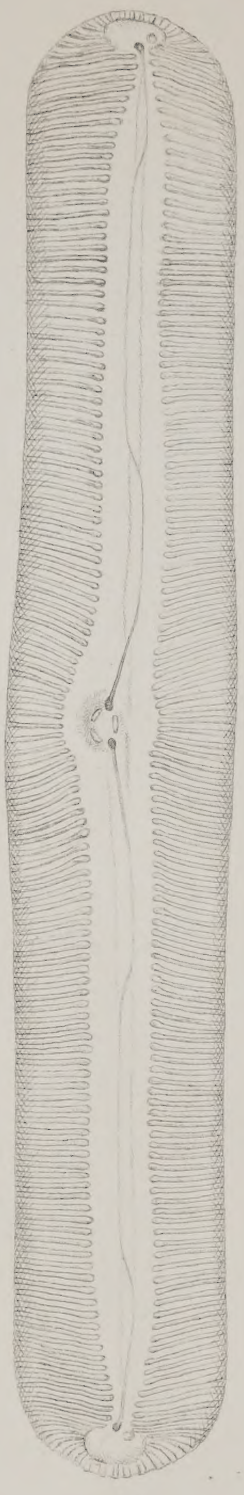
PLATE XI.

Fig. 1. NAVICULA NOBILIS, Ehrenberg. S. V.

2. NAVICULA MAJOR, Kützing. *a*, S. V.; *b*, M. V., the latter showing the typical form and relative breadth of this surface of the frustule in Subsection II. Section II. of the genus *Navicula*. The M. V. of *N. Clepsydra* (Pl. X. fig. 2*b*) shows the typical form and relative breadth in Subsection I. of the same Section. A comparison of the two forms will show the characters on which the two subsections are founded.

1



2.a.

2.b.

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PLATE XII.

Fig. 1. Navicula gentilis, Donkin. S. V.

2. Navicula acrosphæria, De Brébisson.

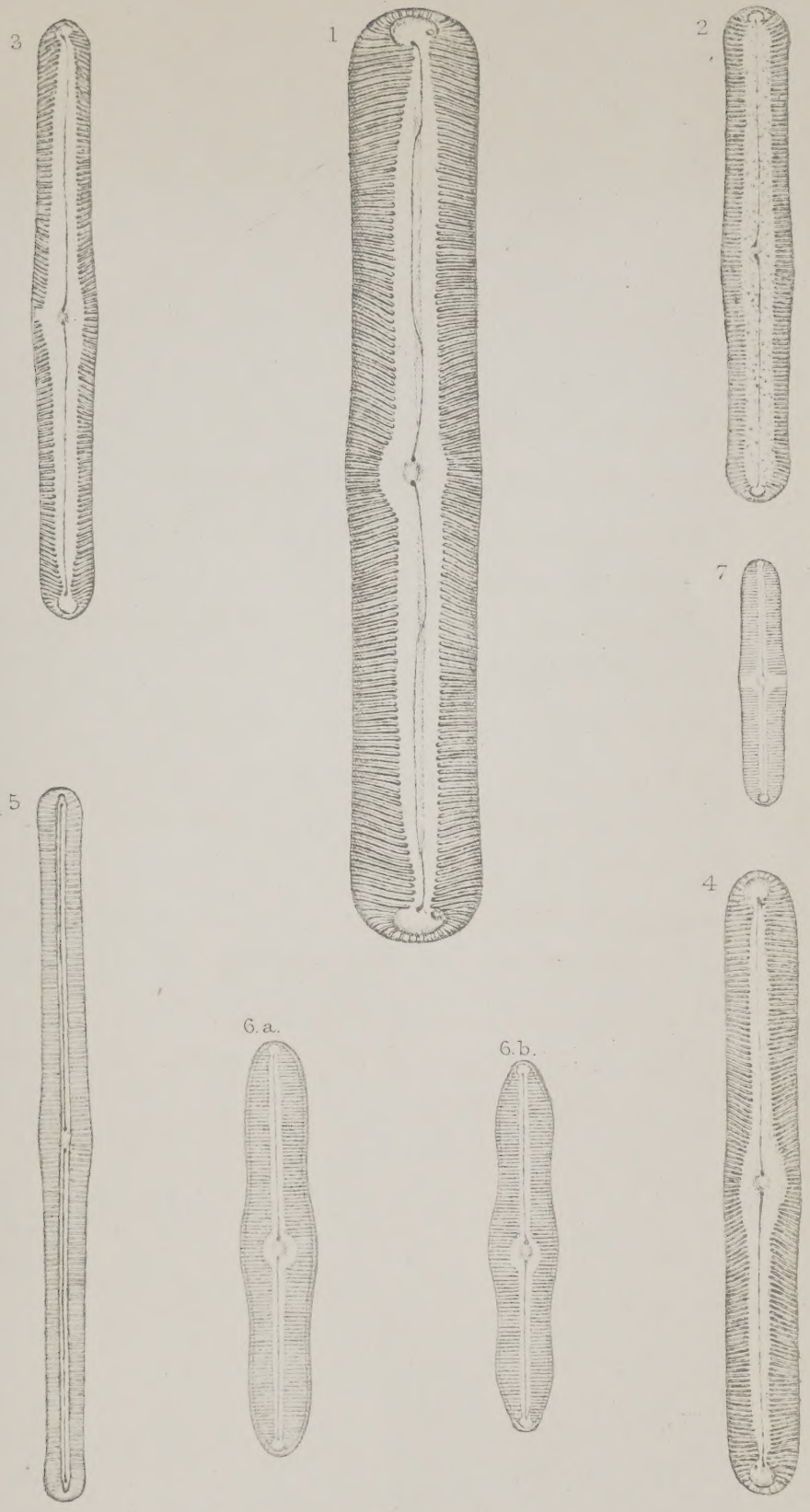
3. Navicula gibba, Ehrenberg. S. V., a large specimen from Loch-Oich deposit; it is frequently smaller and more dilated at the extremities than in the figure.

4. Navicula Tabellaria, Ehrenberg. S. V.

5. Navicula scopulorum, De Brébisson. S. V. The striæ are much finer than delineated in the figure.

6. Navicula limosa, Kützing. *a*, var., with rounded extremities; *b*, S. V., typical form.

7. Navicula ventricosa, Ehrenberg. This species is generally more tumid in the middle than in the specimen figured.



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